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Fundamentals of IT project management

Recommended by Methodical Council of Igor Sikorsky Kyiv Polytechnic Institute as a study guide for students, who study in the specialty 122 «Computer Science»

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Fundamentals of IT project management

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An indispensable component of IT professional skills to be mustered is the project management tools. “Fundamentals of IT project management” textbook is dedicated to the basics of a multifaceted and complex subject area of project management to the extent necessary to teach students of the specialty 122 "Computer Science". This study guide provides general and practical material, thematic glossary, description of project management software. It reviews the content of the Guidance on project management ISO 21500.

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1. GENERAL CONCEPTS AND CLASSIFICATION OF PROJECTS. PROJECT MANAGEMENT STRUCTURES

There are many definitions of the term "project", each of which is used, depending on the specific task the specialist is solving. Here are some of them:

In its most general form, a project is "a planned undertaking" (Webster Dictionary).

From a system point of view, the project can be defined as a process of transition from the initial state to the final state - the result, applying a number of limitations and mechanisms.

In PMBoK [1], a project is a task with certain initial data and necessary results (goals) that determine the way of solution. The project includes the concept (problem), implementation (problem solving) and the results obtained during the implementation (Fig. 1.1).

The concept of "project" combines various activities, characterized by a number of common features, the most common of which are the following:

- focus on achieving specific goals;
- time limitation with definite beginning and end;
- limited resources and finances.

The project is a unique, non-cyclical activity. Production cycles in their pure form are not projects. Recently, however, the project approach is increasingly applied to processes focused on continuous production.

A project being a sequence of tasks exists for a time needed to achieve the final result. The concept of the project does not contradict the concept of the enterprise and is fully compatible with it. Moreover, the project management often becomes the main form of enterprise activity, this is especially characteristic for large IT companies.

An investment project is understood as an investment activity that involves the investment of a certain amount of resources, including intellectual, financial, material, human, to achieve certain goals in a definite time period to obtain the result of a certain quality. The result of an investment project usually is profit.

The definition of the project for IT organizations and developers of software and hardware systems can be specified as follows:

Project - purposeful, substantiated and planned development or modernization of software and hardware of software systems, technical and organizational documentation for them, management decisions using the material, financial, labor and other resources allocated for the implementation of the project.

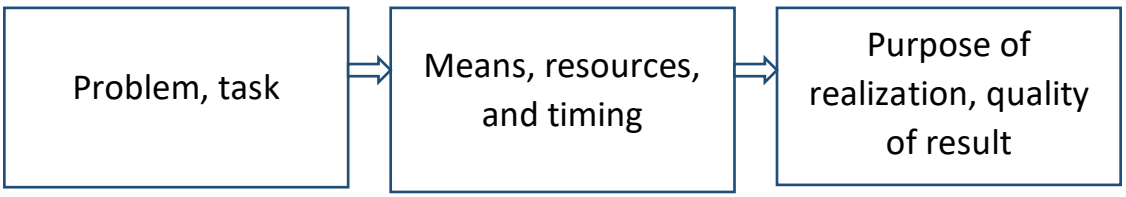

Fig. 1.1 - Main elements of the project

Basic concepts of the project:

The **projec**t is often seen as a specific task with necessary means of implementation in order to achieve the desired economic, technical, technological or organizational result.

The hallmarks of the project are:

- focus on achieving specific goals;
- coordinated implementation of interdependent actions;
- time constrained with defined start and end times;
- uniqueness.

Aim for achieving the stated goals. A clear statement of the ultimate goal of the project contributes to its successful implementation, provided that the interim interdependent goals are formulated correctly. The implementation of the project means the consistent achievement of the goals from the lowest level to the highest, that is, from the beginning to the end.

Coordinated execution of performers' actions. Some actions need to be done in parallel, others - sequentially, and any violation of the order of their execution can jeopardize the implementation of the whole project.

Time and resource **constraints**. Projects are executed over a definite period of time, with clearly defined start and finish as much as possible. The key to successful implementation of the project is the optimal allocation of efforts and resources over time, which is ensured by the defining of the sequence of tasks and activities within the project. However, the design approach is increasingly being applied to continuous production. The resources of the project should be defined in advance and limited by the amount of investment in the project.

Uniqueness. All projects have distinctive features. There are no identical projects, even if they involve doing the same.

Due to the fact that project management methods depend to a large extent on the scale (size) of the project, the timing of implementation, quality, limited resources, location and conditions of implementation, let us consider the main types of so-called special projects, in which one of the factors listed playing the dominant role and requires special attention, while the influence of other factors is neutralized by standard control procedures. Below are listed the "classic" types of "normal" projects, classified in scope, timing, quality of implementation, limited resources, constructive implementation, and participants.

Small projects are small in scale, simple and limited in scope. Examples of typical small projects are: pilot research facilities, small (often block-modular) industrial plants, modernization of existing plants.

Small projects allow for a number of simplifications in the design and implementation process, and the project team formation (you can simply redistribute intellectual, labor and material resources). However, the complexity of correcting mistakes due to the short of time left for their elimination requires a sufficiently careful determination of the volume characteristics of the project, project participants and their methods of work, project schedule and report forms, as well as contract conditions.

Megaprojects are targeted programs that contain many interconnected projects, having common purpose, allocated resources and implementation schedule. Such programs may be international, national, regional, cross-sectoral, sectoral and mixed. As a rule, programs are formed, maintained and coordinated at the upper levels of government: state (interstate), country, or regional.

Mega projects have a number of distinctive features:

- high cost;
- finance capacity - the need for financial resources in such projects, as a rule, requires unconventional (joint-stock, mixed) forms of financing, usually by a consortium of firms;
- complexity;
- long implementation time;
- the need for other countries to participate;
- remoteness of the areas of implementation, and therefore additional infrastructure costs;
- impact on the social and economic components of the environment of the region and even of the country as a whole.

Table 1.1. Types of projects

Signs	Types of projects				
By project interaction	Project		Program		System (Projects folder)
In scale (in size)	Small		Average		Megaproject
In complexity	Simple	Organizationally complex	Technically sophisticated	Resourcefully complex	Complexly complex
By terms of implementation	Short-term		Average		Megaproject
By quality requirements and facilities	Defect-free		Modular		Standard
For resource requirements	Multiproject		Monoproject		
By level of participants	International (compatible)		State, territorial, local		

Complex projects involve the availability of technical, organizational or resource tasks, the solution of which involves non-trivial approaches and increased costs for their solution. Of course, in practice, there are "beveled" variants of complex projects with a predominant impact of any of these types of complexity, such as the use of non-traditional construction technologies, a large number of project participants, complex funding schemes, etc. - all this is a manifestation of the complexity of projects.

Short-term projects are usually implemented at enterprises for the production of innovations of all kinds, experienced installations, restoration works. In such cases, the customer usually accepts the increase of the final (actual) cost of the project compared to the initial, since he is most interested in completing it as soon as possible.

International projects are usually of considerable complexity and cost. They are also distinguished by their important role in the economics and policies of the countries for which they are developed.

Such projects are usually based on complementary relationships and partners' capabilities. Often joint ventures are created to address the objectives of such projects, bringing together two or more participants to achieve certain commercial goals under some common control. In this case, each partner contributes and in some way participates in the profits.

Project management structures

There are several types of structures that are widely used in project management: functional, matrix and project [2].

Functional management structure. Within such structure, the line manager acts through a group of subordinate functional authorities, each managing certain units within the assigned functions (Fig. 1.2).

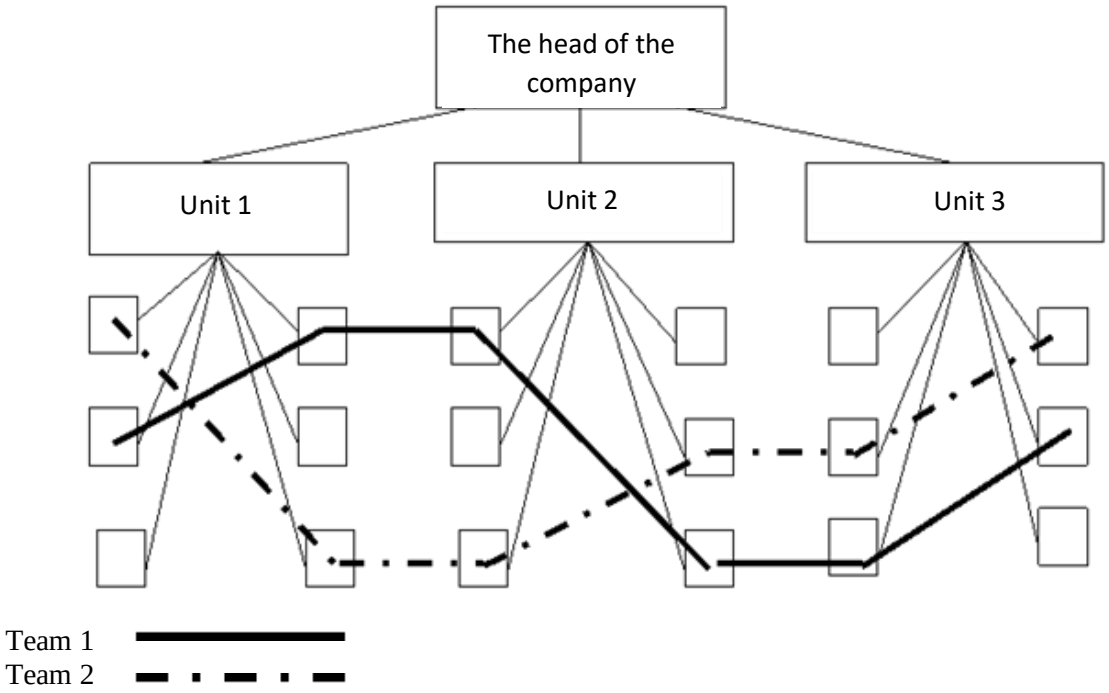

Fig. 1.2. Functional organizational structure

Matrix management structure is created on the basis of functional. In this case, the relationship is based on direct vertical relationships "head - subordinate". To address specific problems, temporary project teams are created, headed by project managers. These groups are formed from specialists of the relevant functional departments, which are placed at different levels of the management hierarchy. Project managers interact with functional departments horizontally; these links are superimposed on the traditional vertical head-subordinate relationship, forming an interaction matrix (Fig. 1.3).

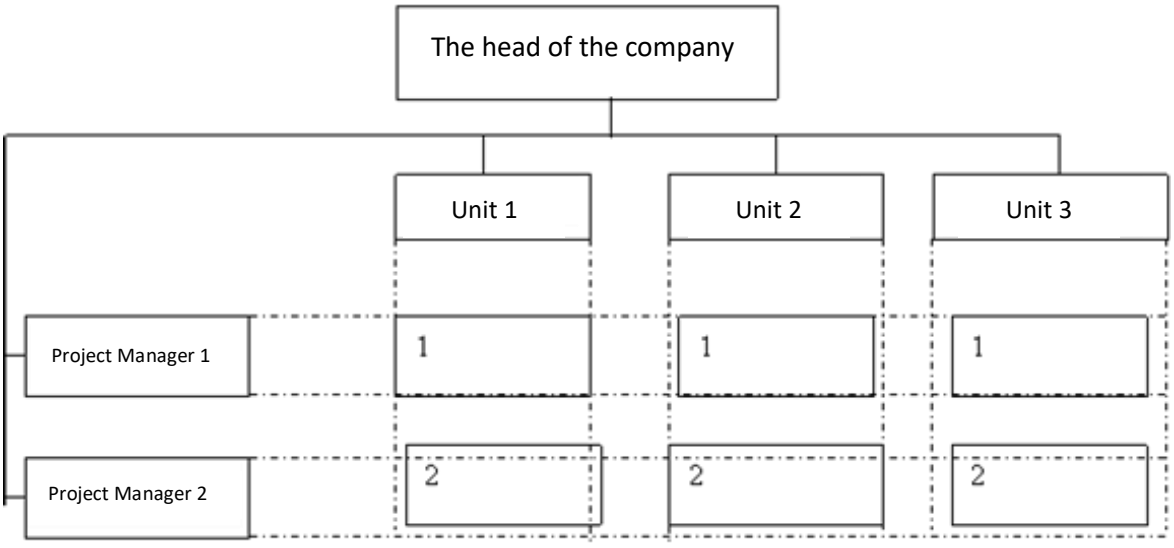

Fig. 1.3. Matrix control structure

The matrix management structure allows for flexible maneuvering of human resources due to their redistribution between projects. In order for this structure to be effective, it is necessary to have an effective system of project tasks execution control, quality control, the costs and the timeframe management. It is necessary permanently to ensure that the actual indicators meet the targets.

The project manager must obtain detailed information on the status of the project implementation in general form, and heads of departments - on the work performed by their departments. These data

are based on reports that project managers discuss with their subordinate groups. Such meetings can be held weekly, and in critical situations - every day.

It is advisable to use the matrix structure of management when implementing small and medium-sized projects. For large projects, such a structure is ineffective, since it dramatically increases the complexity of the communication network, which leads to a significant slowdown in management decision-making processes.

Project management structure. When solving problems related to reorienting the goals of the organization or changing the ways to achieve them, the most effective form of project implementation is the project management - the complex management of human, financial, material and energy resources necessary to ensure the implementation of the project in a definite time period within the planned budget and with appropriate quality (Fig. 1.4).

The project management organization meets the requirements of a systematic approach, according to which the approach providing the solution of a certain problem or achievement of the final goal is built not on the basis of an enterprise hierarchical structure, but focused on the achievement of a specific goal or the solution of a certain problem. To manage the development of specific projects and programs, combined groups are created having appropriate authority. They are designed to insure the overall, global goals of the organization to prevail over the private, local functional goals; to increase responsibility for the final result of the work; decentralize the solution of operational tasks by providing flexible and prompt response to changes in external and internal conditions.

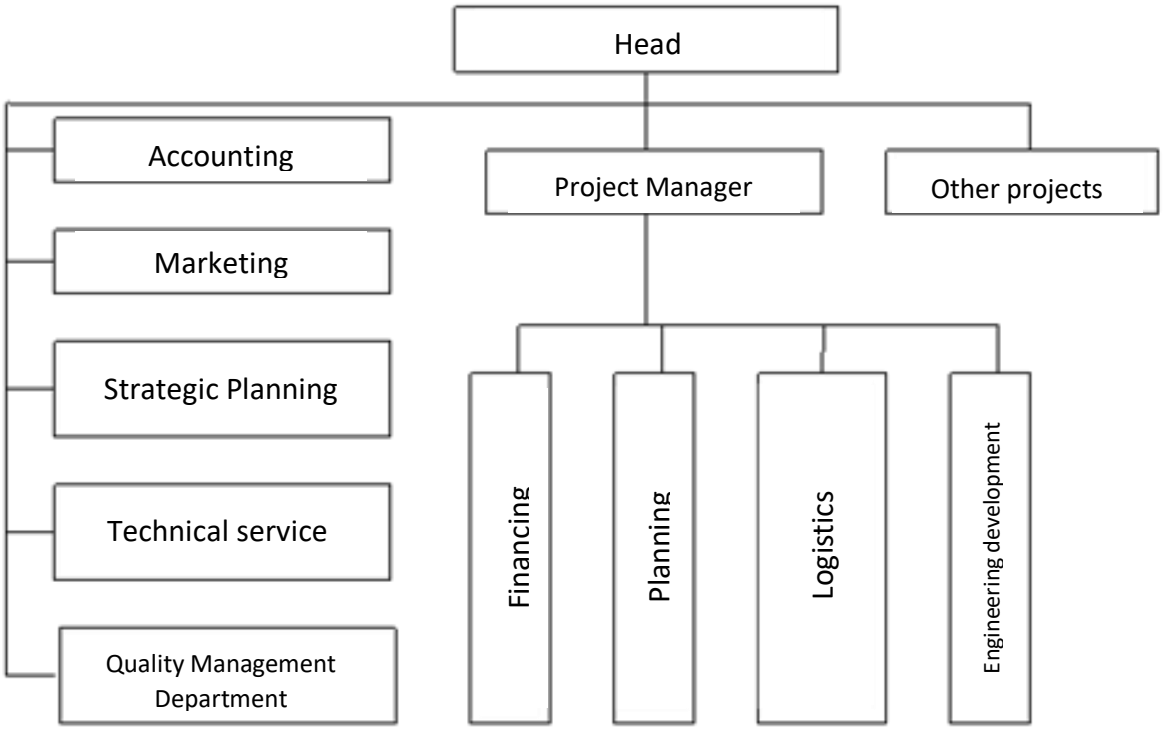

Fig. 1.4. Project structure of project management

Project management, as an organizational form, initially had the form of temporary structure, which was realized within the existing linear-functional organization structure. The life cycle of such an organizational form depended on the time during which the organization achieved its goals and objectives. In the process of this organizational form activity, a special organizational mechanism, i.e. a qualitatively new scheme of interaction between units and individual contractors, began to appear. This process demanded scientific and methodological justification of the new organizational forms of project management.

According to the project management structure created for a specific task, such as the design and construction of the facility, a special working group is created in the enterprise, which is disbanded

after the end of the project. The personnel and resources involved in the working group are returned to the corresponding structural units. To solve the problems of future development the company creates a special department focused on the strategy, while project managers concentrate efforts on the execution of specific tasks.

One of the important problems that arise in organizational structures built on the principle of project management is the distribution of functions between the so-called project and organizational levels of management. In other words, it is necessary to decide which part of the control center can be delegated to a lower project level and which functions to leave at the top level. Conflicts between the center and the project team arise mainly due to the existence of issues that are addressed by both levels of management and by the uncertainty that requires decision at both organizational and project levels of management.

At the project level, project decisions are prepared for the further transfer to the organizational management level.

Authorities at the organizational level, select projects to be executed, determine the deadline for their development and implementation, and distribute resources among projects. The selection of projects and the timing of their completion are strategic tasks, the solution of which requires a large amount of knowledge in many fields - engineering, economics, sociology, etc.

These levels of management interact by sending guidance information from top to bottom, and current project data from the bottom to the top. At the same time, aggregated information is transferred to the organizational level. In order to check the activity of the project teams, they are periodically evaluated, most often after the completion of the current phase of the project.

One of the important problems on which the overall effectiveness of project management depends is the evaluation of the activities of the functional member in the project management system. Usually in such systems functional executor is subordinate to at least two executives: the functional manager and the project manager. From one side, the contractor is subordinate to the head of structural unit, from the other, temporary, during the work in the project he is subordinate to the project manager. Often, a performer is involved in several projects at the same time and can therefore subordinate to several executives concurrently. In general, the problem of evaluating the performance and potential of individual employee is very complex. Most of the time, it is done after the project is completed or the project manager is about to promote the employee.

Project management systems focused on the final goal - completing the project, concentrate on reducing the implementation time, increase the efficiency of solving current issues related to the project, balancing coordination of the work program with the resources of the contractor; resource savings, as well as a more objective assessment of individual performers.

It can be noted that the project management systems have some drawbacks. The organizational structure is the most important mechanism of project management. It gives the opportunity to realize the whole set of functions, processes and operations necessary to achieve the goals set before the project.

Questions to Section 1.

1. What is a project from a system standpoint?
2. What are the distinctive features of the project?
3. What are the types of projects?
4. What are the main structures of project management?
5. What are the main elements of the project?

2. PROJECT MANAGEMENT METHODOLOGY

Historically, project management originates from network planning that was developed in the US in the late 1950s. The first project management knowledge base was published in 1986 (PMBoK 1 edition), and in 2008 there were already 4 editions available. By the same time, in 1989, the PRINCE2 Information Technology Project Management (abbreviation for PRojects IN Controlled Environments) project was started in the UK [3], which was then substantially improved and expanded to all industries. Project management is considered to be basic in England and throughout the Commonwealth with Australia and Canada inclusive. In Japan, a knowledge base of 600 pages in Japanese has been developed, the summary of which was published in 2001 in English (p2m) [4].

PMBoK [1] is considered to be the most complete theoretical description of all project management issues. Until the third edition, PMBoK included no other entities than the project.

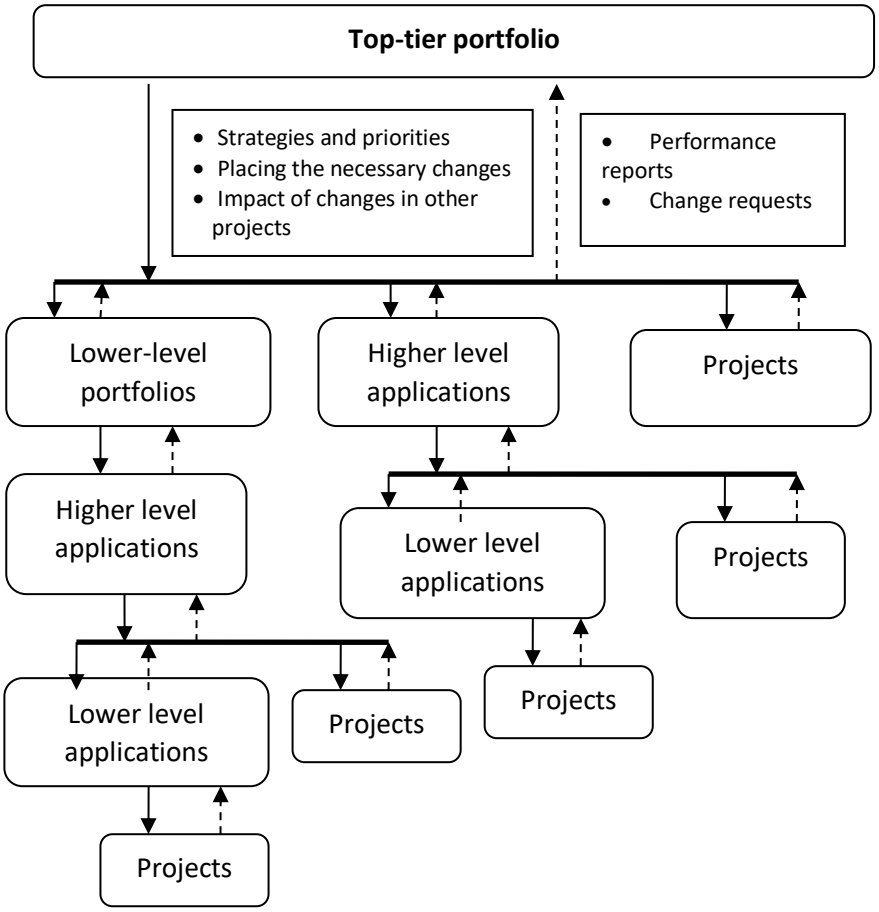

Fig. 2.1. Interaction between Portfolios, Programs and Projects (PMBoK)

PMBoK is focused on the process of preparing and executing projects as a final standalone unit. In this approach, it is impossible to justify the choice of particular projects for implementation and to determine the feasibility of implementing projects. This part of the knowledge relates to strategic management issues. For project institutions, these issues are not urgent, since the activity of the enterprise itself fully justifies the implementation of projects as a final goal. In institutions with a functional organizational structure, the validity of using a project management approach is not obvious. For a long time, it was believed that in such organizations, projects could only be of secondary importance. It was also considered that the implementation of the project approach requires the restructuring of the company, which in many cases eliminated even consideration of this issue.

Over time, it became clear that justification for implementing a project approach in operation-oriented institutions and having a functional organizational structure with rigid management vertical is

possible only if consideration of these activities is raised to a higher level than the strategic management level of the enterprise. At this level, project management is already viewed as a method of achieving the strategic goals of the enterprise.

Today, this approach is gaining ground throughout the world. As the third edition deals only with projects and related to the project lifecycle, the new sixth edition of PMBoK [1] introduces program and portfolio management sections. Depending on the size of programs, projects and portfolio management, the relationship between them can be in several levels. According to the new version, the relationship between portfolios and projects can be depicted using the diagram shown in Figure 2.1.

The fourth edition and the subsequent revisions to the sixth PMBoK provide the definition of different features of projects, programs and portfolios (Table 2.1).

Table 2.1. Comparative analysis of project, program and portfolio management

	PROJECTS	PROGRAMS	PORTFOLIO
Contents	Projects have well-defined goals. Content can change over the life of a project.	Programs have a large scale. As a result, they bring much greater benefit.	Portfolios are business-wide and changing with the changing strategies of the organization.
Planning	Managers are constantly converting high-level information into detailed plans throughout the project lifecycle..	Program managers develop an overall program plan and create high-level plans to manage component-level detailed planning.	Portfolio managers create and maintain the necessary processes and communications for an aggregate portfolio.
Management	Project managers manage the project team to achieve project objectives.	Program managers manage program staff and project managers. They form a common vision and control.	Portfolio managers can manage or coordinate the work of portfolio staff.
Monitoring	The project manager supervises and controls the creation of the product, services, and results for which it was initiated.	Program managers monitor the progress of program components to ensure that goals, schedules, budgets, and program outcomes are met.	Portfolio managers track the aggregate productivity and behavior of indicator metrics set for portfolio.

For the first time in the fourth edition, the connection of projects with strategic management appears, but the consideration of this issue is very brief and general, without detail.

Also, for the first time in the fourth edition, the project office is considered as the only body whose functions depend on the level of project management maturity in the organization.

The main function of the project office is to support project managers, which include:

- Distribution of common resources among all projects within the competence of the project office;
- Definition and development project management methodology, best practices and standards;
- Consulting, tutoring, instructing and training;
- Control compliance with project management policies, standards, procedures and templates through project management audits;
- Development and management of project management policies, standards, procedures and templates;

– Coordination of communication between projects.

Project managers and the project office have different goals and therefore meet different requirements. Example:

The project manager focuses on the implementation of the specific project, and the project office manages major changes in the volume of programs that can be considered as potential opportunities to better achieve business goals;

The project manager controls the resources made available to the project for the best fulfillment of the project goals, while the project office optimizes the use of the collective resources of the enterprise for all projects;

The project manager manages the constraints of one project (content, schedule, cost, quality, etc.), and the project office manages methodologies, standards, overall risks and opportunities, as well as enterprise-wide project relationships.

For the first time in the fourth edition of PMBoK, a distinction is made between project management and operational management. This is the reason for using this document when considering project management in organizations with a functional structure characterized by a high amount of operational activities.

The UK standard PRINCE2 [3], which declaratively relies on PMBoK as a theoretical source, approaches the design and implementation of projects from a more practical point of view, as is evident from the overall project management scheme (Fig. 2.2). The PRINCE2 methodology is supported by the UK government's OGC Office of Government Commerce and is recommended for use throughout the Commonwealth. It details the documentation that must accompany each stage of the project. PMBoK is responsible for initiating the project, sponsoring the project, which determines the feasibility and necessity of the project, and the PRINCE2 standard designates a special project management body. In this standard, projects take on a somewhat different meaning. As can be seen from Fig. 2.2, this chart introduces a new “project start” process whose input, embodied in the project mandate document, derives from strategic management and describes the boundaries of competence. Strategic management is outside the project management itself, and is the source of the projects. According to PRINCE2, this process is different from and precedes the project initiation process. It is at this stage of the project that it is determined whether it is advisable to carry out the project, the approach to the project implementation is selected, the project board, to which the project manager is constantly reporting, is appointed. The project board does not belong to the project team, but controls the project in terms of strategic management. The project board consists of three persons: Customer, Chief User and Chief Specialist. At the same stage, two Business Case documents and a Project Brief are formed. The business case contains information to justify the initiation and continuation of the project (this information answers the question "Why?"). During the implementation of the project, this document is constantly revised and updated throughout the project. If for any reason this document loses its actuality, the project should be terminated immediately.

The project summary is an expanded and refined version of the project mandate that has been agreed with the project board. This document is an input for the project initiation phase. The project summary sets out the project objectives, functional and operational requirements for the completed project. Based on the project summary at the project initiation stage the project team develops all project plans.

In the Japanese standard P2M [4], more attention is paid to the place of project management in strategic management. Moreover, more attention is paid to the personal qualities of the project manager. The requirements for the project management specialist in this standard are very high, because he is responsible not only for the implementation of the project but also for its impact on the state of the institution, and in case of large projects, on the state of society and the environment also.

The key word throughout P2M is to create value for the enterprise, whether commercial or social, and to maintain a continuous chain from the mission of the enterprise through mission-defined strategies, strategy-driven programs, and projects that form part of these programs.

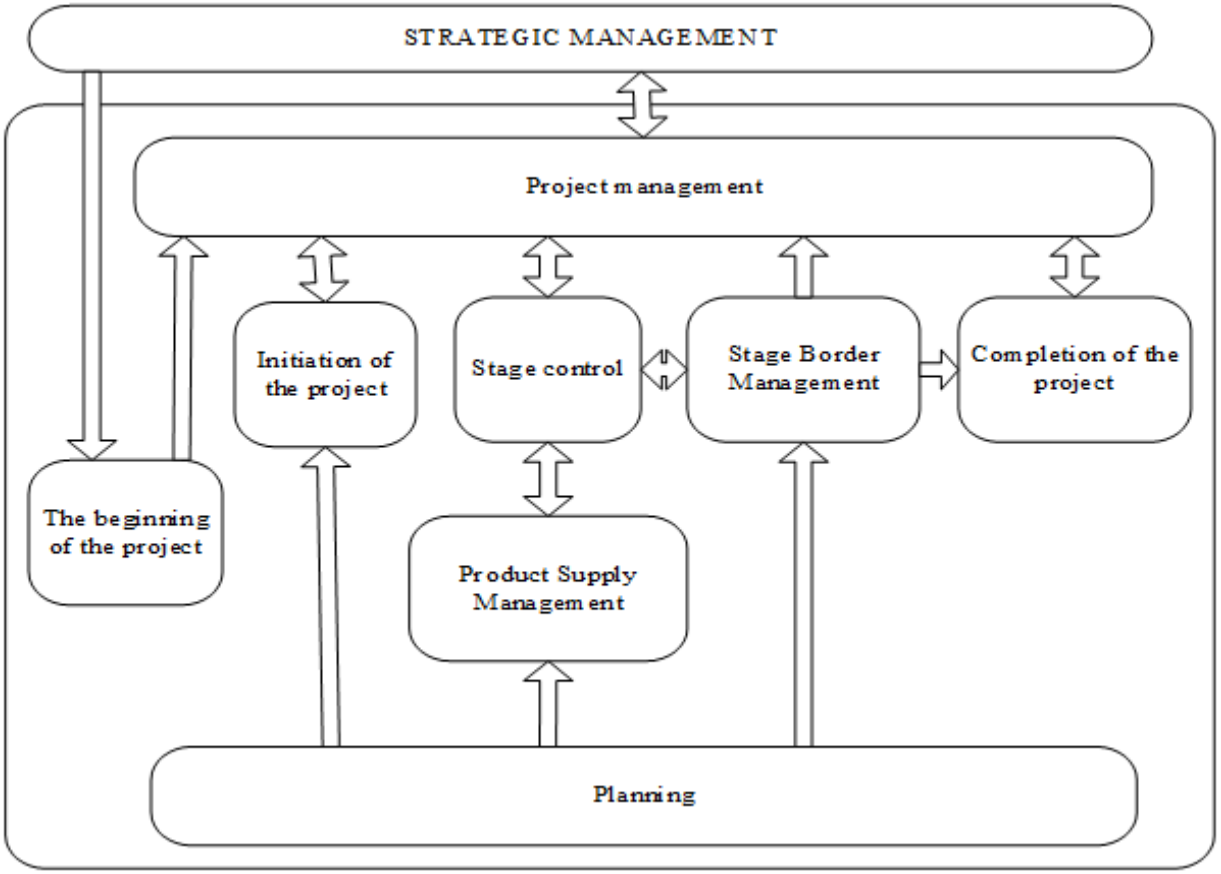

Fig. 2.2. Process diagram of the PRINCE2 method, the arrows indicate the direction of information flows

In this document, projects are already strongly linked to strategic management. And project managers become synonymous with Mission Professionals.

From the point of view of completeness of coverage of project activity in the public sphere it is possible to distinguish the following levels, which determine the degree of maturity of enterprises in the project activity, namely:

- managing individual projects (spontaneous);
- managing only important projects;
- managing specific areas of project implementation:
- time management of projects;
- project management;
- project resource management (contractors and responsible);
- project group management (project portfolios, project aggregation).

Recently, the need for simultaneous management of portfolios, programs and projects within an organization aimed at achieving the goals of the organization has been increasingly emphasized. The Office of Government Commerce (OGC), which is part of the Office of the Government of the United Kingdom, has issued a P3O (Portfolio, Program and Project Offices guidance) guide [3], which provides a high-level model of offices of various types. This document lists 6 types of portfolio, program, and project management offices.

Organization Portfolio Office. Permanent Project Portfolio Management Office, which supports the composition and implementation of the portfolio throughout the organization, as well as changes in the activities of the organization resulting from the implementation of projects and programs that are part of the portfolio. Possible functions of the office: formatting the portfolio of the organization, determining the priorities of programs and projects; planning and evaluation; planning resource management capabilities; monitoring the performance of the organization's portfolio; analysis and

reporting on the portfolio of the organization; approval and closure of programs and projects; managing stakeholder relations and communications; managing the implementation of benefits.

Hub Portfolio Office. Permanent Program and Project Portfolio Management Office that supports the creation and execution of a portfolio of projects and programs in a department, subdivision, regional or business unit.

Possible functions of the office are: creation or update of a portfolio of the unit and determination of priorities of programs and projects; planning and evaluation; planning and managing resources; monitoring of unit portfolio performance; unit portfolio analysis and reporting; approval and closure of programs and projects; managing stakeholder relations and communications.

Program Office. Permanent office for program management, which supports the creation and implementation of the program across the department, division, or region.

Office functions are planning; monitoring; program reviews and reporting; managing the resource pool; managing risks, problems and changes; financial management; management of commercial aspects, including supplier management, quality assurance; information management; management of program development (transitions to subsequent phases of the life cycle); Secretariat services.

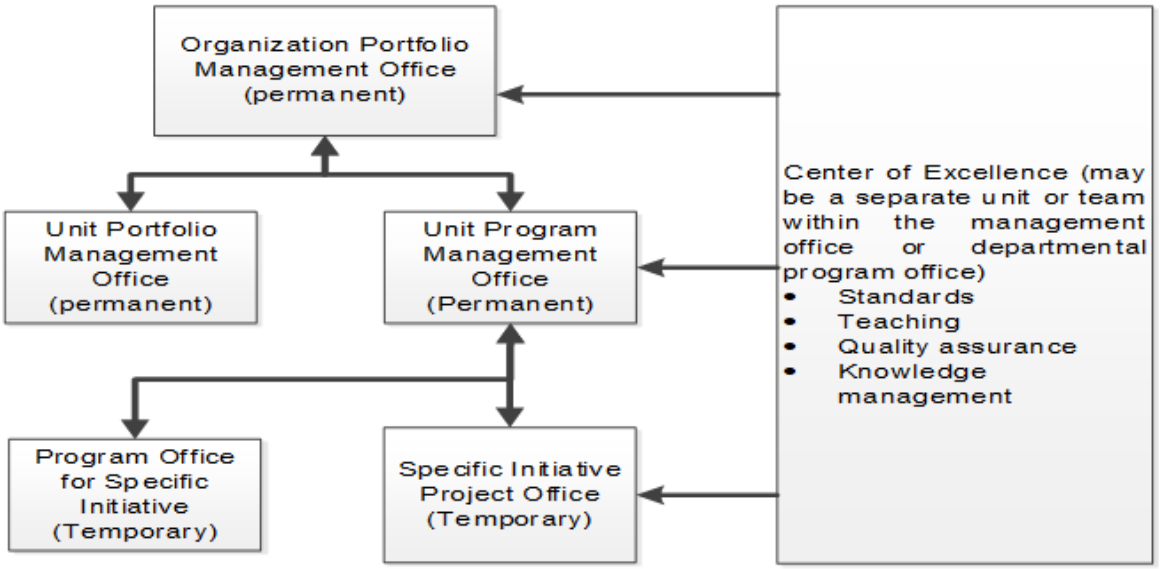

Fig. 2.3. A high-level model of offices for managing portfolios, programs and projects in an organization (according to P3O guidance)

Program Office for a specific initiative. A temporary office established to support the implementation of specific initiatives changing the activities of an organization participating in the program.

Office functions: Planning; reporting; managing risks, problems and change; information management.

Center of Excellence (COE). A unit that sets standards for managing portfolios, programs and projects (including processes, templates, tools), develops skills requirements and provides training to project participants. The Excellence Center can be part of the Portfolio Management Office or act as a separate, independent unit.

Office functions: development and support of implementation of standards and methods of managing portfolios, programs and projects; internal counseling; training in portfolio, program and project management; knowledge management; study and dissemination best practices.

In addition to the above, there are a number of methodologies and concepts in project management that differ significantly in the approaches to the description and management of project processes, but the main goals and objectives that they set and perform, essentially coincide.

Questions to Section 2.

1. What are the features of programs and project portfolios?
2. What is PMBoK?
3. What are the features of the UK PRINCE2 standard?
4. How is the Japanese standard P2M different?
5. What is reflected in the P3O manual?

3. INITIATION OF THE PROJECT. PROJECT PASSPORT

Initiation of the project

(Project Initiation) is a stage in the project management process that results in the authorization of the project start [2, 5].

Project initiation includes the following tasks and procedures:

1. Development of the project concept:

1.1 Analysis of the problem and the need for the project.

1.2 Collection of raw data.

1.3 Defining the goals and objectives of the project.

1.4 Developing a concept for individual project management functions:

1.4.1 Subject area (consideration of existing options).

1.4.2. Project time (choice of methods and definition of project management procedures, time parameters, choice of software for scheduling, determination of time constraints, development of an integrated calendar plan for project implementation, determination of requirements for project management system by time parameters).

1.4.3 Cost (development of project cost and finance management strategy, definition of goals and objectives, success and failure criteria, constraints and assumptions, economic analysis and project justification, marketing, cost and sources of financing, development forecast, overall economic assessment, development of a consolidated financing schedule, determination of requirements for the system of cost management and financing in the project).

1.4.4 Quality of the project (development of a quality management strategy in the project, definition of general requirements and principles of quality assurance, requirements to the quality management system).

1.4.5 Risks (definition of project risk management objectives, analysis of risk factors and uncertainties, identification of possible sources of risk, selection of project risk management strategy, analysis of alternatives, determination of requirements for risk management system).

1.4.6 Personnel (development of personnel management strategy, determination of project manpower needs, definition of project team structure and functions, formation of team life cycle, analysis of capabilities to provide the project with the necessary specialists, determination of requirements for personnel management).

1.4.7 Communications (identification of project participants, definition of project background documentation, definition of communication requirements, justification and choice of communication technologies for project management).

1.4.8 Contracts (marketing of products and services market, development of contract management strategy, compilation of product and service specification, identification of possible sources of acquisition of resources).

1.4.9 Changes (developing a change management strategy, analyzing possible changes, defining principles for integrating change management processes).

2. Consideration and approval of the concept.

3. Initiation of the project (actual):

3.1 Decision to start a project.

3.2 Definition and appointment of the project manager.

3.3 Decision about provisioning of project implementation resources.

The stage of project initiation is characterized by a great degree of uncertainty of the initial and resulting data, the possibility of changing them and the limited time for decision making.

- The most typical tasks during the project start-up phase are:
- Formation of project team;
- Defining the goals and scope of the project;
- Identification of necessary equipment and materials;
- Explanation and development of basic conditions
- Definition and creation of project organization;
- Definition of cooperation procedures;
- Initial project planning;
- Development of project summary (passport).

The launch of the project is also part of the project team building activities. The goals of building a project team at the start of a project are:

- Develop a common vision for the project by defining the context of the project, its goals and objectives;
- Achieving certainty in the plans by defining the scope of future work, the project organization and the existing quality, cost and time limitations;
- Supporting the work of the project team coordinating the mode of operation and communication channels to be used.

Orientation of the project team to the project goals and methods for their achievement.

Aims and objectives of the project

Project Objectives - the desired result of successful implementation of the project under the given conditions.

The **Project Strategy** defines the directions and basic principles of project implementation, characterized by a set of qualitative and quantitative indicators against which the project implementation is evaluated.

When defining project goals, one can limit to the definition of the abstract desired result. Answers to the following questions are to be found:

- How exactly should the project result look like? (qualitative and quantitative characteristics of the project outcome);
- What conditions should be taken into account when implementing the project? (requirements and restrictions).

The objectives of the project describe the full range of major project-related issues, such as technical, financial and organizational aspects, issues related to quality, safety, human resources, supplies, information systems and technology. They consist of three main indicators: results (products and services of the required quality), time (duration and specific dates) and costs (man hours and other costs).

A set of interrelated goals, which must be clearly defined, can be built for each project.
Processes for defining goals and objectives are:

- formulation;
- structuring;
- coordination;
- fixation.

Project passport

The main document that is being developed at the project initiation stage is the project passport. The development of a project passport is the process of developing a document that formally mandates a project or phase, and documents the initial requirements that meet the needs and expectations of

project stakeholders. The project passport establishes a partnership between the implementing organization and the organization that has submitted the application (or the customer, in the case of external projects). The approved project passport formally initiates the project. The project manager is selected or appointed as soon as possible, usually during the development of the project passport and definitely before the start of planning. It is recommended that the project manager is involved in the development of the project passport, since this document gives the project manager the authority to use the resources for the project implementation.

Project is authorized by a person or group of persons external to the project team, such as a sponsor, a Project Management Office (PMO) or a portfolio management committee. The level of project initiator or sponsor must be sufficient to fund the project. They either develop the project passport themselves or delegate this responsibility to the project manager. The initiator's signature on the passport authorizes the project. Projects' authorization is conditioned by internal business needs or outside influence. This usually demands executing of the needs analysis, economic justification, or a description of the situation addressed by the project. Writing a Project Statute links the project to the organization's strategy and ongoing activities. A simplified structure of the inputs, outputs and tools and methods for building a project passport is shown in Figure 3.3.

The basis for the development of a project passport is a description of the project works to be done.

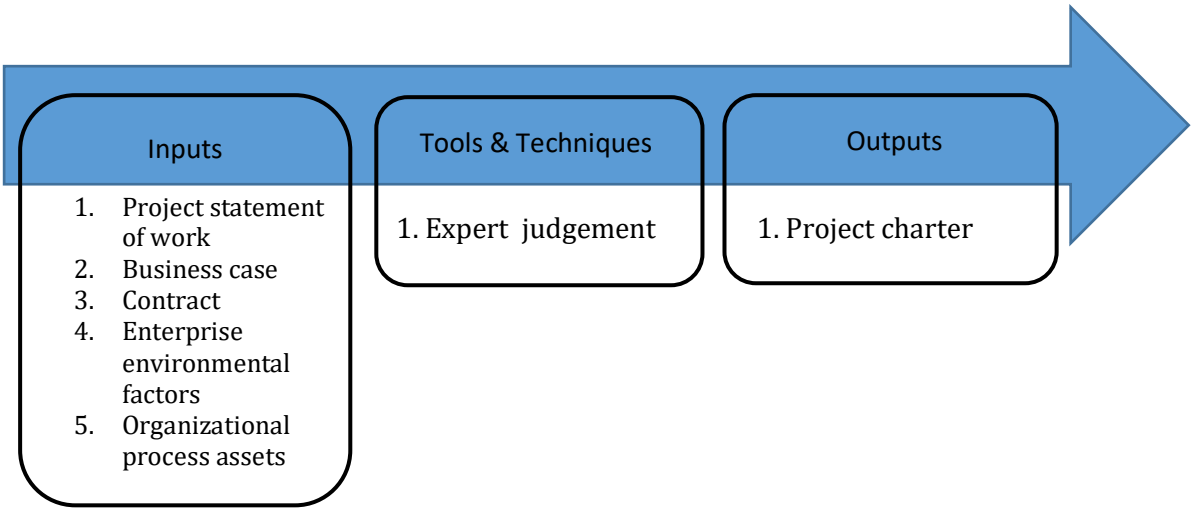

Fig. 3.1. Inputs, tools and outputs of project passport development

Statement of work (**SOW**) is a verbal description of the products or services the project must produce. For internal projects, the project initiator or sponsor provides a job description based on business needs, product or service requirements. For external projects, the job description may be obtained from the customer as part of the tender documentation, such as a request for a proposal, a request for information, a request for proposals, or as part of a contract. The list of works reflects:

- Business needs. An organization's business need may be based on market demand, technological advancement, legal requirements, or government regulations.
- Description of product content documents the characteristics of the product for which the project is being created. The description should also reflect the relationship between the products or services being created and the business need to be met by the project.
- Strategic plan. All projects must support the strategic goals of the organization. The strategic plan of the organization should be considered as one of the factors in on project selection and prioritization.

Another important element of preparation is the economic justification of the project.

The economic justification or similar document provides the information, necessary from a business point of view, to determine whether the project is worth the investments required. Usually,

the business case contains business needs and a comparative analysis of costs and outcomes to justify the project.

The economic justification may be written by the applicant organization or the customer in the case of external projects. Economic justification is based on analysis of one or more of the following factors:

- market requirements (for example, a car company authorizes a project to produce more economical cars in response to a lack of gasoline);
- the needs of the organization (for example, a training company authorizes a project to create a new training course to increase profits);
- customer requirements (for example, a state-owned company authorizes a project for a new district telecommunications network);
- technological progress (for example, a computer manufacturer is authorizing a new project to develop a faster, more economical and compact laptop using the latest advances in computer memory and electronic component manufacturing technology);
- legal requirements (for example, a paint manufacturer authorizes a project to develop recommendations for the management of toxic materials);
- environmental impacts (for example, a company is designing a software system to analyze the environmental impact of a city's industry).

If the project consists of several phases, the economic justification may be reviewed periodically to ensure that the project is on the right track to achieving business benefits. In the early stages of a project's lifecycle, periodic review of the economic rationale sponsored by the organization also helps to ensure that the project is still needed.

Contract

The contract is important for creating a project passport if the project is executed for an external customer.

Environmental factors of the enterprise or organization for which the project is being developed.

Factors of the enterprise environment that may influence the process of developing a project passport include, but are not limited to:

- state and industry standards;
- the infrastructure of the organization;
- market situation.

Assets of organization processes

Assets of organization processes that may affect the project passport development process include, but are not limited to:

- standard organization processes;
- rules and description of typical processes for use in the organization;
- templates (e.g. project passport template);
- Historical information and lessons learned.

Tools and methods for developing a project passport:

Expert assessments

Expert assessments are often used to evaluate the inputs used to develop a project passport. Similar assessments and expertise in this process apply to any technical and management details. Such examinations are conducted by any person or group of persons with specialized knowledge or skills and are available from many sources, including the following:

- other units within the organization;
- consultants;
- project stakeholders, including customers or sponsors;
- professional and technical associations;
- industry associations;

– Experts on specific issues;
– Project Management Office (PMO).

Example of project passport composition:

1. Project goals;
2. Approximate project duration and possible steps;
3. Description of the project product: qualities, opportunities, advantages;
4. Implementation strategy;
5. Project scope;
6. Required project resources;
7. Functional volume;
8. Geographical scope of the project;
9. Technical volume;
10. Important assumptions (limitations);
11. Organizational structure of the project and functional roles;
12. Quality assurance, goal achievement indicators;
13. Review of methodology;
14. Conceptual design;
15. Implementation and final testing;
16. Operation and support (project support);
17. Project volume change management;
18. Possible risks;
19. Regular quality assurance;
20. Knowledge transfer (knowledge base formation);
21. Terms (action plan, implementation schedule).

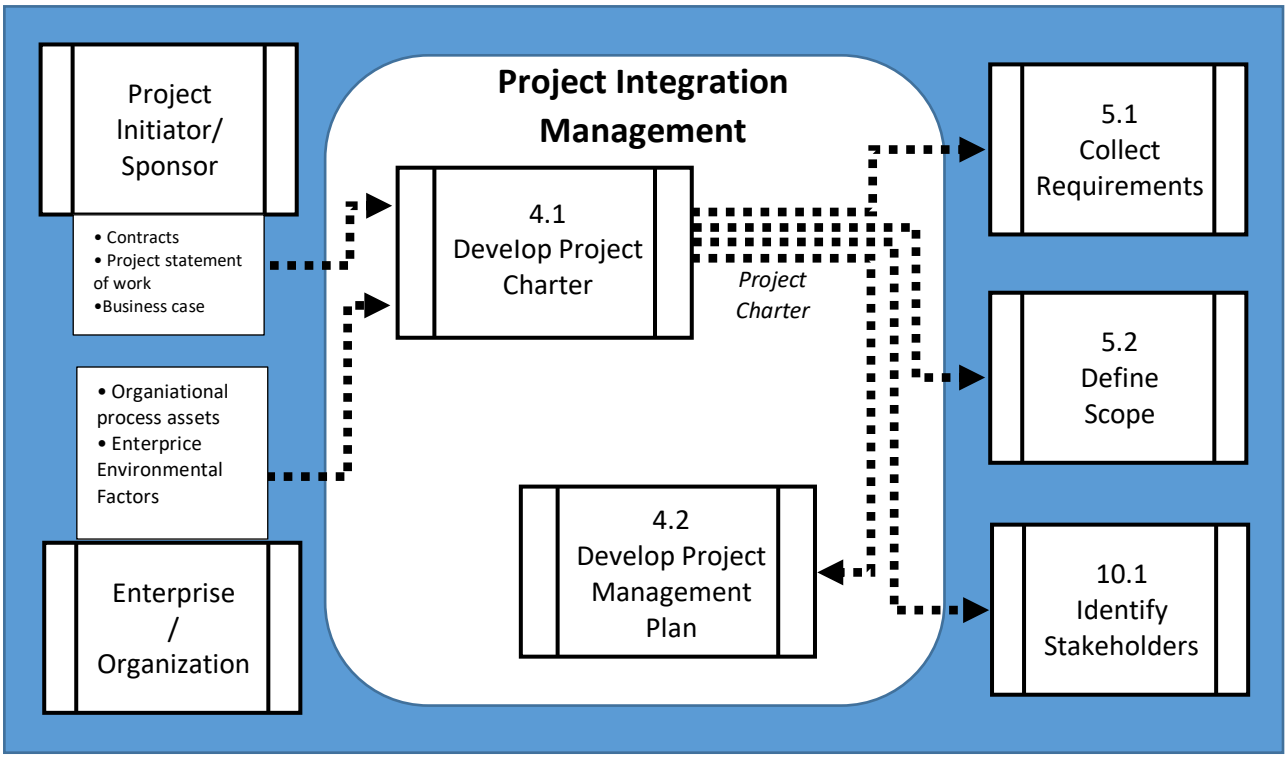

Fig. 3.2. Scheme of data flows when building a project passport

An important element of the project passport development is the interaction of data flows that link the individual elements of the structure of the project passport. The scheme of data flows in the construction of the project passport is shown in Fig. 3.2.

Questions to Section 3.

1. What is project initiation in project management?
2. What procedures the project initiation involves?
3. What is the purpose of the project?
4. What is a project passport?
5. What are the main sections of the project passport?

4. PROJECT PLANNING. WORK BREAKDOWN STRUCTURE (WBS)

Project planning

Project Planning is a continuous process of determining the best course of action to achieve the project's goals, taking into account the current situation. Planning is the most important project management process that determines time distribution of all project implementation activities [6].

Project planning is the process of making decisions that determine the order in which the sequence of individual activities, actions and work on the project should occur.

Planning is central to project management, being the organizing start to the whole process of using it.

The planning processes are carried out throughout the whole project lifecycle, starting with the preliminary coarse plan being part of the project concept and ending with a detailed work plan of the final phase of the project. In this case, the plans are refined and detailed as the project progresses. The planning stage defines the organization, methods and means of managing the implementation of the project, as a whole system, in terms of its individual stages and elements.

At the planning stage of an IT project all the necessary parameters for its implementation are determined:

- duration (in general and for individual tasks);
- the need for personal, logistical and financial resources;
- delivery terms of equipment, software and services;
- terms of software development and testing;
- involvement of external organizations in the project;
- terms of training and preparation of documentation.

Planning is related to other important stages of the management process, such as the initiation, execution organization and control, analysis and regulation, closure of the project.

The purpose of the planning is to build a project implementation procedure. The main result of the planning stage is the project implementation plan, which integrates the planning results from all project management functions. This document is one of the main and decisive in the implementation of the project, it serves as a model (sequence) of actions and status of the project and its environment.

Changes can take place both inside and outside the project. Therefore, the primary purpose of planning is to continually direct the project implementation towards its successful completion.

Project planning objects are:

- subject area;
- time;
- cost;
- quality;
- organization;
- communication;
- risks;
- deliveries and contracts;
- changes.

A project management plan is a collection of all project plans (documents). Possible list of the project management plan documents [7]:

Scope management plan - a document that describes how the content of the project will be defined, developed and verified and the work breakdown structure (WBS), as well as how to manage the content of the project.

Time Plan / Schedule is a document that sets the criteria and operations for developing and managing a project schedule.

Cost management plan - a document that defines the format, operations, and criteria for planning, structuring and managing the cost of the project.

A quality management plan is a document that defines the quality standards the project must meet and the means to achieve those standards.

Employee Management Plan / Staffing Management Plan - A document describing, how resources are distributed.

Communication Management Plan - A document that identifies information and communication needs of project participants: who they are, what their level of interest and impact on the project, who needs it, when it is needed, and how it will be provided.

A risk management plan is a document that describes how a project's risk management will be organized and implemented.

Procurement Management Plan - a document that describes the management of supply processes, from the development of procurement documentation to the closing of the contract.

Milestone plan - milestone is a definitive event or date in the course of a project. A milestone plan is a sequence of milestones defined by a manager.

Project change management plan – is provided in case you need to make changes to the project management plan. Such changes may occur due to project modifications, additions and revisions. In this case, the status of the plan changes to updated.

Possible algorithm for planning an IT project:

- Determine how planning will be done;
- Collect and finalize requirements;
- Form a concept;
- Decide “what to buy”;
- Identify the team;
- Create a WBS (hierarchical work structure);
- Create an activity list;
- Create a network diagram;
- Assess the resources needed;
- Estimate duration of action and cost;
- Schedule;
- Create a budget;
- For quality planning - create metrics;
- Create a process improvement plan;
- Allocate roles and responsibilities;
- Create a communication plan;
- Plan risk management, identify risks, qualitative analysis, quantitative analysis, plan risk response.

Planning the subject area of the project

Project Scope is a set of products and services, the production of which must be provided as a result of the project completion. Objective of the project is determined by the goals, results and works of the project. During the life of the project, all components of the subject area may change.

The overall results, works and their characteristics can be modified or refined both during the project development process and after the intermediate results are achieved.

Project area planning includes the following tasks and procedures:

WBS (Work Breakdown Structure) is a basic tool for creating a project management system and allows:

- solve problems of organization of works;
- distribution of responsibilities;
- cost estimates, reporting system creation;
- effective maintenance procedures for collecting information on work performance;
- displaying results to summarize work schedules, costs, resources, and completion dates.

Project time planning

The Time Plan / Schedule plan is a document that sets out the criteria and operations for a project schedule development and management.

The coordinated work of all project participants is organized on the basis of calendar plans or task schedules of project, the main parameters of which are: deadlines, key dates, task duration and others.

The time planning of the project consists of drawing up various calendar plans (work schedules) that meet all requirements and limitations of the project and its parts.

The calendar plans are project documents that establish a complete list of project tasks, their relationship, the sequence and implementation timing, duration, as well as contractors and resources required to perform the project. The calendar plans are drawn for the whole project life cycle and its stages, for different levels of management and project participants.

The project scheduling consists of the following steps:

1. Preparation of work breakdown structure (WBS).
2. Determination of the project tasks list based on the project work breakdown structure (WBS).
3. Determining the sequence of works and their interconnections using organizational and technological models. Clarification of temporary restrictions.
4. Determination of tasks duration.
5. Project network diagrams construction.
6. Gantt chart drawing.
7. Project work schedules optimizing with temporary criteria.
8. Approval of calendar plans.
9. Project management plan by time parameters.

Let's take a closer look at the individual stages of scheduling, the development of which is most time consuming.

Work Breakdown Structure (WBS)

Project work breakdown structure (WBS) is a breakdown of the project into components (tasks, jobs), with details that are necessary and sufficient for its effective planning, monitoring and management [8].

The main tasks of WBS development are:

- determining the degree of project works detailing (so that they can be evaluated);
- determining the number of levels (usually three to four, for modern companies - four optimally);
- development of the structure of each level (horizontal levels are formed);
- preparation of a description of the WBS elements (the short name of each WBS component);
- coding system development (all blocks are coded);
- reversed calculations (costs for each block are calculated).

You can create multiple WBSs for the same project with different levels and sublevels at each level, depending on the principle that underlies the breakdown of the project into its components.

WBS is a basic tool for creating a project management system and allows:

- solve works organization problems;
- allocate responsibilities;
- evaluate the cost;
- create reporting systems;
- effectively maintain procedures for collecting information on work performance;
- display results to summarize work schedules, costs, resources, and completion dates.

WBS enables:

- determine the hierarchy of results;
- describe the full scope of work required to achieve the ultimate goals and project quality;
- build a mechanism for evaluating project performance by workload and cost;
- develop a system of accounting for project elements and the project as a whole.

Work breakdown structure is a graphical representation of the hierarchical structure of all project works.

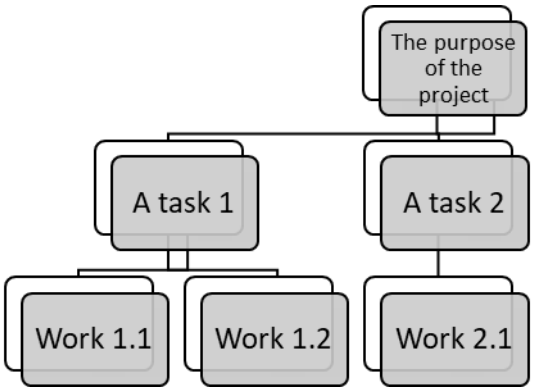

Fig. 4.1. Project work breakdown structure

WBS is a central tool for determining the work to be carried out within the project. The project description should include:

- content of works;
- predictable results;
- conceptual boundaries;
- integrated planning and management;
- successive measurements and evaluations of project progress.

The following rules must be observed when constructing WBSs:

1. Lower level jobs are the means to achieve top level jobs.

2. Each top-level job may include several lower-level jobs, the achievement of which automatically ensures that the result of the upper-level work is achieved too.

3. Each lower level job can be included in only one upper level job.

4. The decomposition of the top-level work into the lower-level tasks is performed by single common criterion, which may be: components of project outputs and products, stages of the project life cycle, resources and functional activities, as well as elements of the organizational structure.

5. At each level, the tasks must be equivalent. Equivalence criterion can be: volume and/or time of task.

6. In constructing a WBS at different levels, different decomposition criteria can and should be applied.

7. The sequence of work decomposition criteria should be chosen in so that most of the dependencies and interactions between the works are found at the lowest possible levels of the WBS.

The upper levels of work should be autonomous.

The work decomposition is terminated when the lower-level jobs satisfy the following criteria:

– the tasks are clear and understandable to the project manager and participants (they are elementary);
– ending result of the work and ways to achieve it are clear;
– temporary characteristics and responsibility for tasks can be clearly defined.

Decomposition

Decomposition of project work as a technological component of project development means the division of the main project into separate more detailed components to reach a level that provides the necessary and sufficiently detailed information for effective project management.

The degree of detail of the WBS depends on the size of the project and the complexity of the tasks, the possible risks and requirements of the project manager and stakeholders to control the project.

The degree of detail can also vary throughout the project lifecycle and in all its stages.

For small and short-term projects at the initial stage, it is possible to develop the entire WBS to the lowest detail level (to the final employee), whereas in large time-consuming ones, the volume of work and the level of complexity of projects, as a rule, do not permit full work detail at the initial stage.

The full WBS for such projects can be done successively in the course of their implementation. Thus, for a particular project, individual work groups may have different levels of decomposition.

In particular, it is done when developing projects with the plan decomposition for task starting immediately, and future work is defined as groups of tasks without detailed decomposition, and at later project stages it will be possible to define them in more detail.

The basis for the breakdown of the project into task groups and individual tasks can be:

– the components of the product to be obtained as a result of the project (software, services, activities, new features, etc.);
– elements of software and hardware used to implement the project;
– functional elements of the organization activity implementing the project;
– the main phases or stages of the project life cycle;
– units of the organizational structure that will use the project results;
– geographical location for distributed projects.

Figures 4.2, 4.3 show examples of decomposition.

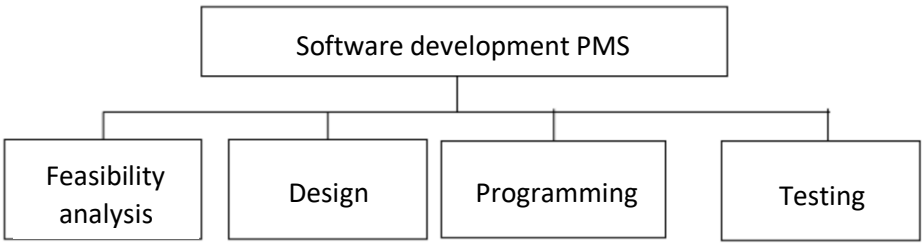

Fig. 4.2. Decomposition of software development (example)

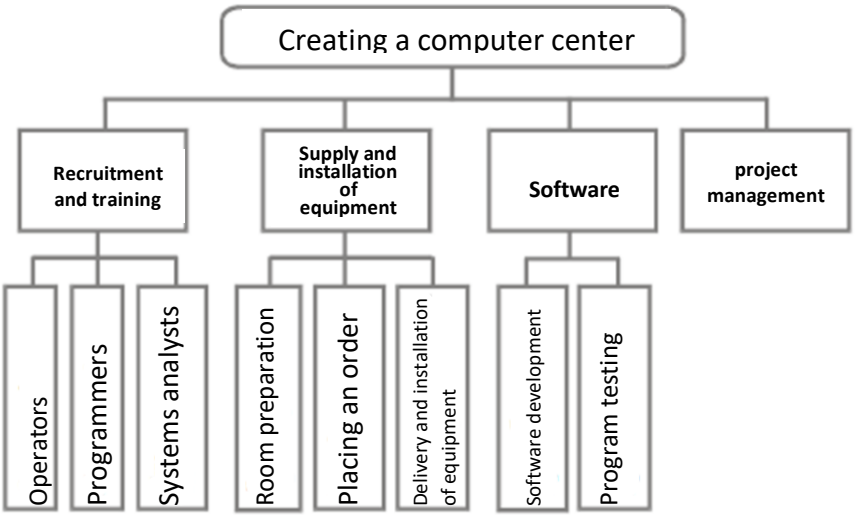

Fig. 4.2. Decomposition of the computer center building (example)

Let us review an example of a project three-level working structure for a computer center creation for an enterprise. The first level is the project itself, the second is the subprojects formed on the product principle: human resources, technical support, software and project management. Work packages for the first three subprojects are located at the third WBS level, and project management is not detailed. That is, it should be emphasized that the depth of the breakdown of certain blocks may be different.

Quite often, projects use two-way structuring that combines tasks and organizational structures and is provided for:

- working structure of the project (WBS);
- the organizational structure of the project (OBS);
- cost accounting;
- description of work packages (activities).

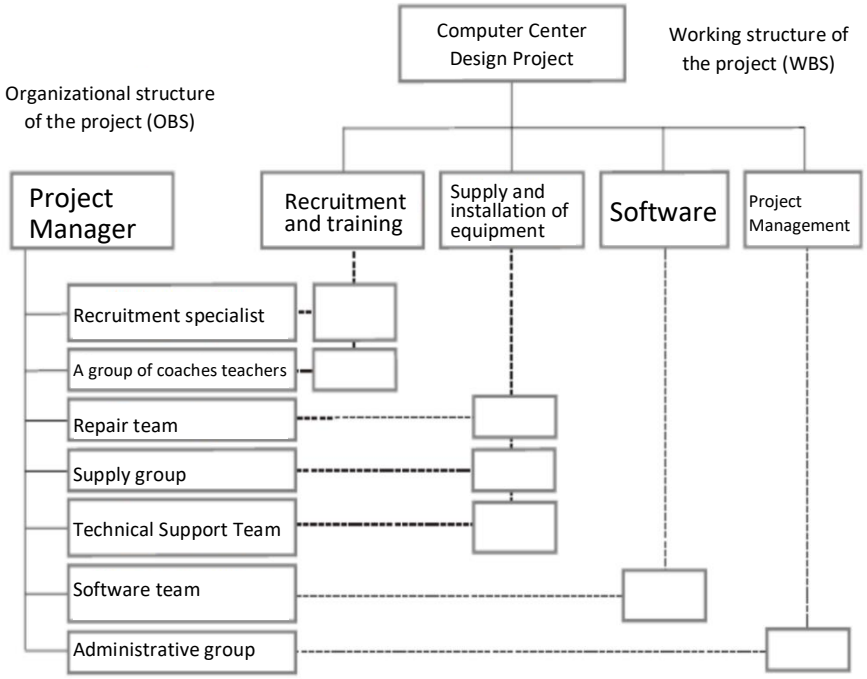

Fig. 4.4. Two-way project structuring

When creating a tasks schedule, one must specify the duration of each project task. This duration can be calculated on the basis of standards or can be specified based on personal experience. Often, we cannot determine the duration of a particular job. In this case, we can use the PERT method.

PERT (Project Evaluation and Review Technique) method

The PERT method is a network event analysis method that is used to determine the duration of a project when there is uncertainty in estimating the duration of individual tasks.

PERT is used along with the critical path method. Project duration is calculated as a weighted average of optimistic, pessimistic and expected forecasts. The PERT method calculates the standard deviation of the end date from the duration of the critical path.

Work duration can be calculated in this case as a weighted average of optimistic, pessimistic and expected forecasts.

Critical path method

Critical Path - The maximum length of a full path on the network, and tasks which are on the critical path are also called critical.

Critical task is a task that determines the duration of the entire project. Increase in duration of the critical task causes the increase of the whole project duration.

Non-critical tasks have a time reserve. If this time reserve is exhausted in the process of implementation, the task becomes critical and its duration begins to affect the duration of the entire project.

Network Planning

The search for more effective ways of planning complex processes has led to the creation of fundamentally new methods of **network planning and management (NPM).** PMBoK methodology uses Gantt charts for network planning.

Network planning and management systems are a set of graphical and computational methods, organizational activities and control techniques that provide modeling, analysis and dynamic restructuring of the implementation plan of complex projects and constructions.

System of methods of NPM - system of planning and management methods for developing of large software and technical complexes, scientific, and technological researches applying the network graphs.

The NPM system allows:

- create a calendar plan for the implementation of some set of tasks;
- identify and mobilize time reserves, labor, material and monetary resources;
- to manage the set of tasks on the principle of "leading link" with the prediction and prevention of possible disruptions in the course of work;
- to increase the efficiency of management as a whole, with a clear division of responsibilities between heads of different levels and contractors.

Currently, the most developed is an MPU system in which the input information includes only time parameters without considering the cost of works and resources, that is, the system where time optimization of the set of tasks is described by one network.

The main planning document in the MPU system is a network graph, which is an information-dynamic model that reflects the relationships and results of all the tasks required to achieve the ultimate goal.

When building a network schedule, you must follow a number of rules.

1. There should be no "deadlocked" events in the network model, that is, events that leave no tasks except the final event.

2. The network schedule should not have "tail" events (except the original one), which should not be preceded by at least one job.

3. There should be no closed circuits and loops in the network, that is, paths that connect some events.

4. Any two events must be directly related to no more than one arrow job.
5. It is recommended that the network have one original event and one final event.

Network diagrams of the project

Network diagram - a graphical representation of the project tasks and relationships between them [9].

The purpose of network planning techniques is to minimize project duration. Typically, a network diagram is represented as a graph in which the vertices are the design tasks, and the relationship and sequence of tasks is displayed by connecting lines.

Gantt chart

Gantt chart is a horizontal linear diagram with a time axis on which the project's tasks are represented by stretches proportional to execution time characterized a set of parameters [10].

As shown in Figure 4.5, the tasks of the project are displayed in the form of rectangles, however, unlike the network diagram, in the Gantt chart the length of the rectangle corresponds to the duration of the work. Arrows also characterize the sequence and relationship of the works. If necessary, you can supplement the chart with information on the cost of the works, their contractors.

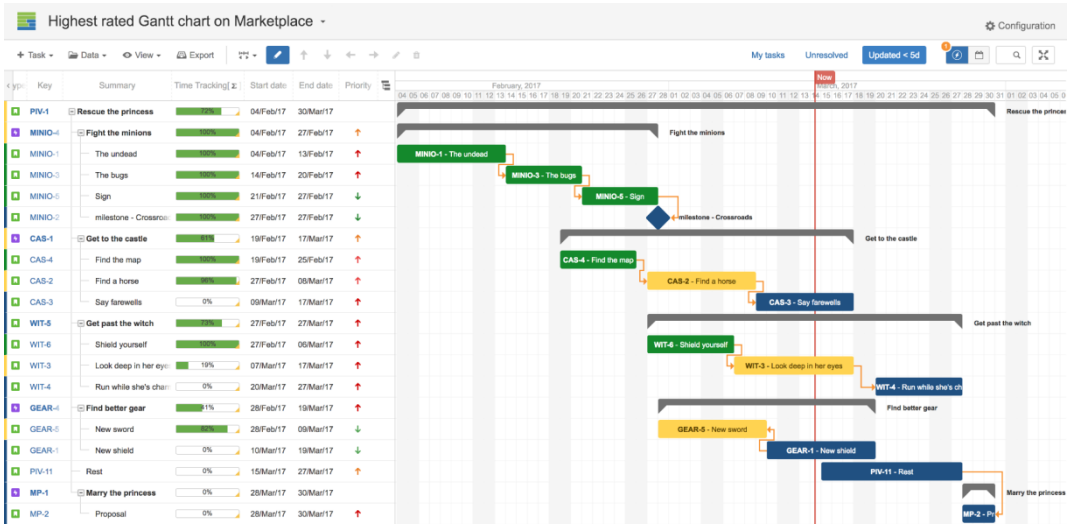

Fig. 4.5. An example of a Gantt chart

Project manpower planning

There are three main stages in project workforce planning:

1. Determination of available labor resources. In other words, compiling a list of employees and their availability (temporary possibilities to use them in the project).
2. Appointment of contractors for each project task.
3. Analysis and resolution of contradictions that have arisen in the calendar.

Project cost planning

Project cost planning consists of the following steps:

1. determining the cost of used resources;
2. determining the cost of each project task, based on the amount of resources spent and their cost;
3. determining of the total project cost;
4. estimation of the project;
5. approval of the estimate;

6. drafting of the project budget;
7. project budget approval.

The cost of **the project** is the sum of the project resources costs and the tasks cost. The cost of the project is determined by the resources needed to complete the work, including:

- Equipment (purchase of software and computer equipment, renting of premises and communication channels, leasing);
- Work of workers (full-time contract employees);
- Consumables (stationery, etc.);
- Materials;
- Training, seminars, conferences;
- Subcontracts;
- Transportation.

A **project estimate** is a document that contains the rationale and cost estimate for a project, usually based on project workloads, required resources, and prices.

A **project budget** is a document that defines the project's resource constraints.

The budget can be in the form of:

- cost allocation matrices;
- calendar plans-schedules of expenses;
- cost charts;
- cumulative cost diagrams;
- charts distributed over time;
- cost structure diagrams.

Questions to Section 4.

1. How is the project planning process defined?
2. What are the planning objects in the project?
3. What are the main parameters of the project implementation?
4. What is included in the project management plan?
5. What is Work Breakdown Structure (WBS)?
6. What are the main tasks of work breakdown structure?
7. What is the PERT method for?
8. What is the purpose and features of the Gantt chart?

5. QUALITY MANAGEMENT. HUMAN RESOURCES MANAGEMENT. SUPPLY MANAGEMENT. CHANGE AND CONFLICT MANAGEMENT

Quality management

Project Quality Management is a project management section that includes the processes necessary to ensure that a project meets the needs for which it was designed [1,6]. It includes quality planning, quality assurance and quality control. Quality management is carried out throughout the project:

- design, organizational and management decisions;
- used materials, equipment, raw materials, etc.;
- quality of work performed during project implementation;
- quality of project results (project products, services provided).

Creating and maintaining the quality of processes and products during the implementation of the project requires a systematic approach. This approach should ensure that:

- needs of the customer are understood and satisfied;
- the needs of other project participants are taken into account;
- the developer‘s method in the field of project quality management is taken into account.

The process of quality management in the project includes:

1. The concept of quality management in the project:

- developing a quality management strategy for the project (defining goals and objectives, success and failure criteria, limitations and assumptions);
- defining general requirements and principles of quality assurance, standards and rules;
- quality management system requirements;
- approval of the concept.

2. Quality management planning in the project:

- creating specification of goals, objectives, evaluation criteria and limitations in quality management;
- defining lists of control objects in the project;
- a description of the project product that influences quality planning;
- defining quality assessment indicators based on international, national, industry and internal standards;
- development of quality management procedures and their description;
- selection of methods and means of quality control and evaluation;
- development of a project quality management plan that describes the project quality management system and implementation of project quality management procedures.

3. Organization and implementation of quality control in the project:

- organization and implementation of quality management in the project;
- technical support for quality control;
- quality control in the project;
- Forming reports to evaluate quality performance.

4. Analysis of the status and quality assurance in the project:

- comparison of actual project results with specifications and requirements;
- analysis of the status and progress of quality in the project over its life cycle;
- technical evaluation of the project product quality;
- the process of checking the conformity of the available quality control results with the existing requirements;
- forming a list of deviations;
- identifying the necessary corrective actions to ensure quality in the project;
- decision on intermediate acceptance;
- clarification of the control lists of objects;
- corrective actions on quality assurance in the project;
- documenting changes.

5. Completion of quality management in the project:

- summary of quality of project results;
- decision on final acceptance;
- list of comments and quality claims;
- resolving controversial issues and conflicts;
- documentation and archive design;
- analysis of experience and creation of knowledge base on quality management.

Human resources management in the project

Project Human Resource Management is a project management section that includes the processes required to make the most effective use of project personnel and other project human resources.

Project human resources are a set of professional, business, personal qualities of project participants and their capabilities that can be used in the project. Project human resource management as a specific project management function is a set of processes, methods, tools and actions used in the project for the most effective management of both project staff, as well as other human resources.

Project Human Resource Management includes processes [11] that require more effective use of the people involved in the project and utilizes the human resources of all project participants:

- sponsors;
- clients;
- users;
- customers;
- developers;
- investors;
- individual contributors;
- suppliers of software and hardware;
- other project stakeholders.

Various specialists with different qualifications are involved in the project life cycle. The number of personnel is involved in the project changes during the project implementation.

Human resources management includes a wide range of tasks:

- determining the qualification and quantity of the project team throughout the project;
- search and selection of candidates, recruitment and dismissal;
- planning the distribution of employees at workplace;
- organization of training and advanced training, determination of responsibilities;
- creating the necessary conditions and working atmosphere for teamwork;
- prevention and resolution of emerging conflicts;
- solving the issues related to payments.

The personnel management process includes:

1. Development of the concept of personnel management in the project:

- developing a personnel management strategy (defining the goals and objectives of personnel management, staffing requirements, restrictions);
- determining the needs in the project's workforce;
- defining the structure and functions of the project team;
- defining the team life cycle;
- analysis of the possibilities to provide the right specialists for a project;
- defining the requirements for personnel management;
- approval of the concept.

2. Organizational planning:

- choice of methods and tools of organizational planning;
- identification of external project participants;
- determining the schedule of staffing needs when creating a project and its elements;
- determining the number and qualification of the project team;
- distribution of roles and responsibilities of project participants;
- formation of the organizational structure of the project;
- developing a personnel management plan.

Organizational planning is done at an early stage of the project's life phases. Organizational planning is often strongly associated with communications planning, because organizational structure has a strong influence on project communications.

3. Recruitment and formation of the project team:

- defining the functional responsibilities of project participants;
- search and selection of candidates.

4. Formation of a project team, including:

- hiring and appointment;
- determination of rights, duties and job descriptions;
- organization of team work;
- definition of payment terms;
- developing a system of sanctions and incentives.

While creating a project team, the main task of the leader is to form a group that is united by the common goals and values, consisting of people with different organizational and professional cultures. The project team must be provided with resources that will meet the project requirements on time.

5. Project team activity analysis and development:

- analysis of project team activities;
- drafting reports on project implementation;
- evaluation of project performance;
- regulation of payments, benefits and incentives;
- conflict management within the project team;
- maintaining the psychological climate in the project team;
- reorganization of the team during the project progress;
- improving the work of the project team.

Team development is often complicated by the fact that individual team members are subordinate to both the functional manager and the project manager (mixed project management scheme). Effective management of this dual relationship is a critical success factor for the project.

6. Completion of personnel management in the project:

- team analysis and evaluation;
- drafting a final report on project implementation;
- conflict resolution based on project implementation results;
- preparation and fulfillment of the final accounting;
- formation of archive and knowledge base;
- disbanding the project team.

There are two fundamentally different outcomes of the project team's activities: successful completion of the project and poor results. In any case, the question of the most painful process - disbanding of the team and the employment of its members is carried out using the same procedures and tools. As in all that is related to personal financial and other interests, as well as interpersonal relations, the main factors of successful and conflictless disbanding of the team are full openness of information on the project, relations of management to team members, form of payment, possible bonuses, terms of its completion, methods of analysis and evaluation of project results.

Supply Management

Project Contracts Management is a project management section that includes the processes required to ensure the delivery of products and services from the outside. This includes supply and service planning, proposal planning, request, sourcing, contract administration, contract closure. Contract and supply management in the project involves processes aimed at purchasing externally the products and services needed to execute the project [12].

Project and contract management includes:

1. Development of the concept of contract management in the project:

- marketing of products and services;
- developing a contract management strategy;
- preparing the specification of products and services;
- identifying possible sources of resource acquisition;
- approval of the concept.

2. Planning of deliveries and contracts to provide the necessary products and services:

- determining the project's needs for products and services;
- conducting market research to identify potential suppliers and contractors;
- choosing a method of securing and maintaining contracts in the project;
- definition of contract types;
- determination of the title list of works and the list of contracts in the project;
- development of the contracting schedule.

3. Organization and preparation of contracts in the project:

- distribution of functions and responsibilities in accordance with the contract management plan;
- preparation of tender documentation;
- invitation to tender;
- bidding and selection of bidders;
- contracting;
- development of reporting system and procedure for making changes.

4. Control and regulation of contracts:

- organization of the contract monitoring system;
- contract work monitoring;
- determining the status and forecasting on works execution and their provision;
- reporting on contracts execution;
- analysis of the current state of contracts execution and requests for changes;
- resolving controversies and discrepancies.

5. Completion of contract management in the project:

- acceptance of the contracts performance results;
- final analysis and evaluation of the project support efficiency;
- closing contracts;
- final contract management report in the project;
- creation of the contract documentation archive;
- formation of contract templates and knowledge base for supply management.

Change management in the project

Project Change Management is a project management section that includes formal processes and procedures for integrating and managing project change throughout its life cycle.

Change management in the project consists of:

- forecasting;
- planning;
- implementation;
- control;
- change management.

Change management is closely linked to all of the processes and functions in the project discussed earlier. In its life cycle, the project may undergo various changes:

- domain, its configuration (Configuration Management);

- time;
- cost;
- quality;
- risks;
- contracts;
- deliveries;
- human resources;
- communication;
- project management processes at all phases of its life cycle.

Change management in the project should be considered as a comprehensive integrated process related to:

- all internal and external factors of the project prior to predicting possible changes in the project;
- identifying changes that have already occurred;
- planning actions to prevent negative impacts on the project;
- change management in the project;
- coordination of all changes throughout the project.

Change management is designed to address the challenges and tasks associated with protecting the project from the potential negative impact of external and internal factors, making the required coordinated changes, and insuring their effective implementation.

The project change management process includes:

1. Development of the concept of change management in the project:

- developing a change management strategy;
- analysis of possible changes;
- defining principles of change management processes integration;
- approval of the concept.

2. Change forecasting and planning:

- selection of methods and tools for forecasting and planning changes;
- forecasting changes;
- monitoring of the environment and trends;
- planning possible preventive actions to protect the project;
- develop a change management plan for the project.

3. Organization and control of changes in the project:

- distribution of the roles and responsibilities of staff involved in change management and building an appropriate organizational structure;
- approval of procedures for implementing changes in the project;
- implementation of the change management system;
- information support for change management in the project;
- collecting and analyzing changes requests and proposals;
- making decisions and making changes to the project;
- keeping a database of project changes.

4. Analysis and regulation of changes:

- control of implementation of changes in the project;
- review and analyze the dynamics of changes in the project;
- ongoing assessment of changes in the project and the results achieved;
- report on implementation of changes in the project and deviations from the change management plan;

– suggestions for adjusting the change plan.

5. Completing project change management:

– after project analysis, evaluation of changes and their results;
– final report on actual changes done in the project;
– forming an archive of changes in the project;
– adjusting the strategy for the future and creating or updating a knowledge base for change management.

Change management is, in some cases, is a part of or a consequence of the needed actions in the conflict management during project activities and implements processes to resolve or reduce conflict situations.

Project Conflict Management

Project Conflict Management is a process in which, through the use of management technology, various mismatches, both technical and personal, that arise in the course of working on a project are resolved. Conflict management essentially is the art of creative conflict resolution [10]. Projects and contracts can create conflicts, even if steps are taken to resolve and prevent them. This happens at all levels of the organizational structure of the project, mainly because:

– The project usually has a large number of co-operating parties, each with its own goals that may conflict with the goals of the other parties;
– The project team, as a temporary formation, often brings together barely familiar people, who are forced to work together within the rigid constraints of the project, in the face of considerable pressure from the project stakeholders.

Conflicts lead to different inconsistencies or their symptoms, which may threaten the achievement of the project goals, although sometimes they can play a positive role in the project. Conflict frameworks can be both a conflict of interest for project participants and be limited just by the interpersonal conflict of individuals involved in the project. They are highly dynamic and can affect the interests of large numbers of people.

A particular case of conflict, characterized by the lack of solutions, the transfer of positions or the long termination of any activity, is called a crisis.

The result of the conflict management process is a positive change in the conflict situation in the project, based on the change of different conditions of the project implementation, requirements for terms, cost of work, form and amount of payment, organization and planning of work, working conditions of contractors and many other factors.

Questions to Section 5.

1. What is meant by quality management in a project?
2. What does the quality management process in the project involve?
3. What are the features of human resource management in the project?
4. What steps does the HRM process include?
5. What are the main tasks of managing deliveries and contracts in the project?
6. What is project change management?
7. What tasks does the project conflict management process solve?

6. PROJECT COMMUNICATION MANAGEMENT. PROJECT TIME MANAGEMENT

Project Communication Management

Project communication management is an activity of managing information communication and, as a management function, this task is aimed to ensure: timely collection, generation, distribution and storage of the required project information [5, 6].

Here information is meant as the collected, stored, processed, and distributed data. To be useful for decision-making, information must be provided on time, on purpose, and in a convenient form. This is achieved through the use of modern information technology within the project management system.

Communication and related information is a foundation for ensuring coordination of project participants. The scheme of information exchange within the organization is presented in fig. 6.1.

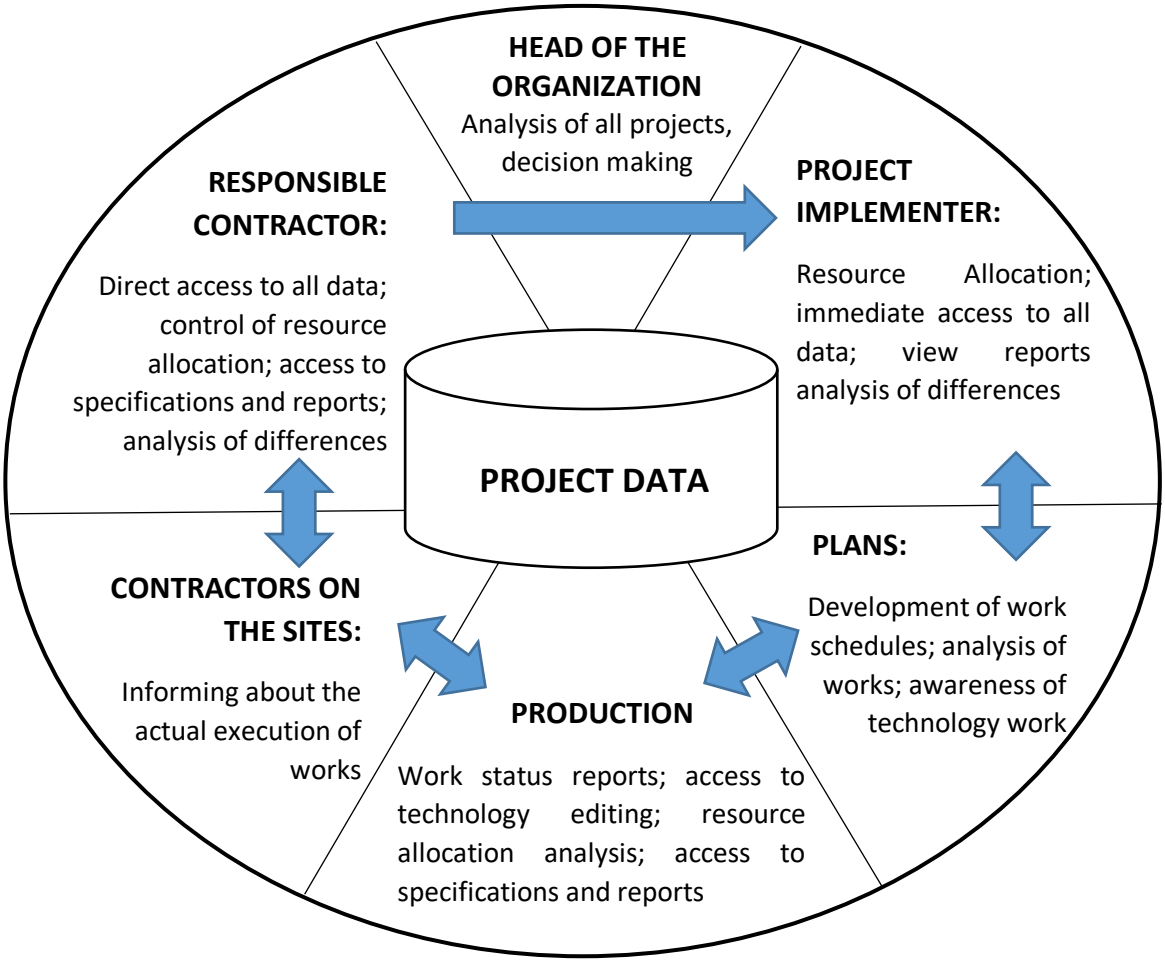

Fig. 6.1. Information exchange in the organization

Communication management provides support for the communication system (interaction) between project participants, management and reporting information delivery for achieving the goals of the project. Each project participant should be prepared to interact within the project in accordance with his / her functional responsibilities. The communication management function includes the following processes:

- planning of the communication system - determining the information needs of project participants (composition of information, terms and methods of delivery);

- information gathering and distribution - processes of regular collection and timely delivery of the necessary information to project participants;
- reporting on the progress of the project - processing of the actual results of the project work, correlation with the planned and trend analysis, forecasting;
- documenting the work progress - collecting, processing and organizing storage of project documentation.

Planning of the communication system

The communication plan is an integral part of the project plan. It includes:

– information gathering plan, which identifies sources of information and methods to obtain it;
– information sharing plan, which defines consumers of information and ways of its delivery;
– a detailed description of each document to be received or sent, including format, content, level of detail and definitions used;
– plan for putting into operation certain types of communications;
– communication plan updating and improving methods. The communication plan is formalized and detailed according to the needs of the project.

Collection and distribution of information

Within the project there is a need for different types of communication:

– internal (within the project team) and external (with company management, customer, external organizations, etc.);
– formal (reports, requests, meetings) and informal (reminders, discussions);
– written and oral;
– vertical and horizontal.

Information collection and distribution systems must meet the needs of different types of communications. Automated and non-automated methods of gathering, processing and transmitting information may be used for these purposes.

Non-automated methods include the collection and transmission of hardcopy data, meetings.

Automated methods involve the use of computer technology and modern communication tools to enhance the effectiveness of interaction: email, workflow and data archiving.

Progress reporting

The processes of collecting and processing actual results and reporting on the status of work in the reports provide the basis for work coordination, operational planning and management.

Progress reporting includes:

– information about the current status of the project as a whole by individual indicators;
– information on deviations from base plans;
– forecasting the future status of the project.

Work progress documentation.

The main intermediate results of the work must be formally documented.

Documentation of work progress results includes:

– collection and verification of the tasks final data;
– analysis and conclusions about the degree of achievement of project results and the effectiveness of the tasks performed;
– archiving the results for future reference.

Computerized systems of electronic archives allow automating the process of storing and indexing text and graphic documents, greatly facilitating access to archival information.

Information technology refers to the whole set of the processes of collecting, transmitting, processing, storing and communicating to users the information that is realized with the help of modern software.

Project Management Information System

Project Management Information System is an organizational and technological complex of methodological, technical, software and information tools aimed at supporting and improving the project management processes.

In the process of project implementation, managers have to handle large amounts of data that can be collected and organized using a computer. In addition, many of the analytical tools, such as recalculation of works with evidence, resource and cost analysis, are quite complex for non-automated algorithms.

The development of project management systems for personal computers has gone through several stages. With the increase of the PC power, the functionality of the systems improved and their capabilities increased. With the introduction of data exchange standards between systems, the proliferation of networked Web technologies, new opportunities have been opened for the further development of systems to support project management processes and their more efficient use. The projects themselves are becoming more complex, which puts additional demands on the development of information technologies for project management.

Today, the information technology for project management can be described by the Fig. 6.2.

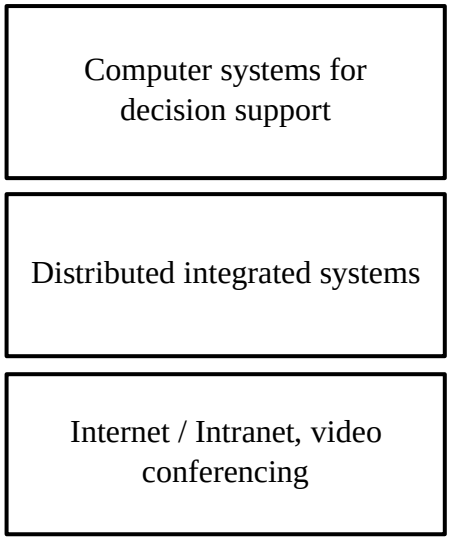

Fig. 6.2. Project management automation

Personal computer systems with project management software installed must provide the following functions:

- work in a multi-project environment;
- development of a project tasks schedule;
- allocation optimization and accounting of limited resources;
- “what-if” analysis;
- collection and evaluation of actual information on timing, resources and costs for automated report generation;
- planning and control of contractual obligations;
- centralized information storage on completed and stopped projects.

Distributed integrated systems use:

- client-server architecture. It allows workstations ("clients") and one or more central PCs ("servers") to distribute the execution of applications using the computing power of each computer. Most client - server systems use databases (DBs) and database management systems (DBMSs). Successful project management requires that the data obtained during project planning and execution would be always accessible to all project participants;

- telecommunication systems (transmission of digital data via optical cables, computed networks, etc.);
- portable computers;
- group work support software that allows:
  - email exchange;
  - workflow;
  - group planning of activities;
  - remote team members participation in interactive teleconference discussions;
  - brainstorming, which allows participants to express their opinions through computers connected to one big screen.

Internet / Intranet are the technologies that bring companies and projects closer together. They provide access to project information without requiring significant funding for its organization. Hosting a project website is the most optimal and probably the only way to inform participants about project's status when they are at different points on the globe.

Created web pages form a web site, which is then hosted on the provider's server, thereby providing access to remote users from all over the world. With regard to project management, web-based work schedules, reports (graphical and tabular), meeting minutes and any other documents related to the project may be published as web pages.

An intranet is based on the same elements as the Internet. The fundamental difference between them is that Intranet users are a limited number of persons, which is usually made up of employees of a particular corporation, organization, or enterprise.

Project Time Management

Project time (duration) management is aimed at planning, controlling, adjusting, analyzing duration and time reserves of tasks from the perspective of project completion on time. Time management involves the allocation of project tasks execution time by successive stages; drawing up schedules for the project and its individual tasks and monitoring their compliance [13, 14].

Implementing a project within pre-determined calendar plans, budgets, and meeting the required product quality metrics is much easier in words than in reality. Management of the project implementation in modern conditions is associated with a large amount of uncertainty the project manager cannot control.

The project consists of a wide variety of activities, such as various meetings, preparation of reports, interaction with the consumer, and many more. The success of individual project activities and the project as a whole is determined by the ability of the project manager to manage his time and his subordinates' time.

For most people, time is a resource (however, an irreversible resource). For a project manager, time is foremost a limitation, and only the skillful usage of time management ensures that it is used not as resource. For effective use of time it is necessary to master not only personal skills, but also existing methods, among which the most accessible and basic are network models.

Project time management includes the following processes required to ensure that project completion is timely.

Activity Definition - the definition of individual tasks, that must be performed to achieve the various objectives of the project.

Activity Sequencing - defining and documenting relationships between jobs.

Activity Duration Estimating - an estimate of the amount of working time required to complete each individual work.

Schedule Development - an analysis of the task sequence, duration and resource requirements for creation of a project schedule.

Network models of tasks sets

The network model of the task package is an oriented graph that is used to describe the relationship between the tasks and the project stages. There is a large number of network models, the most common of which are:

- Network graphs of the critical path method.
- Network graphs of the PERT method.
- Network models of the GERT method.
- Network matrices.

The *critical path method* uses mathematical analysis to determine the early and late dates of project start and finish without limitation on resources, as well as time reserves - periods of time that can be postponed without breaking limits and project completion dates. It calculates a single deterministic project schedule and uses predetermined estimates of project duration.

The *PERT method* uses successive network logic and weighted average task duration to calculate the duration of the entire project. Currently, the PERT method is rarely used, despite the fact that task-time estimates, often based on the PERT method, are used in critical path calculations.

The *GERT method* allows for reliable processing of both network logic and work duration estimates. The following different situations are taken into account: some works may not be performed at all, others may be partially performed, and others may be performed several times.

Network matrices represent a graphical representation of the project implementation processes, where all tasks (management and production) are shown in a certain technological sequence and in relation to the organizational structure of the project by individual executors (structural units, officials and personnel).

Questions under Section 6.

1. What does project communication management include?
2. What is the essence of information exchange in the organization?
3. What does communication system planning involve?
4. What are the features of a project management information system?
5. What is the aim of managing the time (duration) of the project?
6. What are the features of network models of work packages?

7. PROJECT RISK MANAGEMENT

Project risk management is a process of finding, making and executing organizational and financial management decisions directed at reducing the possibility of unfavorable conditions for project implementation and minimizing possible unplanned losses during the project implementation stage [15].

Risk is the potential, identified and measured possibility of adverse situations and their associated consequences in the form of losses, for example, of expected profit, income, property, or cash due to uncertainty, i.e. with a random change in the conditions of economic activity, unfavorable, including force majeure, a general market prices drop; the possibility of obtaining an unpredictable result, depending on the economic decision or action.

Implementation of projects, especially investment projects, is not a well-defined process. Use of the latest technologies, complexity of tasks, lack of the necessary developer's qualification are significant factors that determine the ambiguity of possible situations in the implementation of the project and the uncertainty of the final results. Due to these and many other factors, the progress of project and deliverables is often different from preliminary plans. One of the measures that increase the success likelihood in such circumstances is to use the risk management techniques. Risk

management is the process of identifying, analyzing, and responding to events. The aim is to maximize the likelihood of favorable events and their consequences and to minimize the likelihood and impact of adverse events. However, quite often these measures are limited to dealing with adverse events.

Risks exist in all projects but do not always occur. The risk involved becomes a problem. Risk occurrence in some cases is a kind of event that usually adversely affects the progress of the project and its results. In this context, risk can be considered as the occurrence of some accidental event.

Risk measurement is the evaluation of the likelihood of a risk event. Assessing the risks that the project team and the project investor can take during the project mainly depend on the specifics and importance of the project, the availability of the necessary resources for its implementation and the possibilities of financing the consequences of such risks. The extent of acceptable risks is usually determined by taking into account such parameters as the size and reliability of the investments in the project, the planned level of profitability, etc.

In quantitative terms, uncertainty supposes the possibility of deviating result from the expected (or average) value both in the smaller and in the larger side. Accordingly, it is possible to clarify the concept of risk - the likelihood of spending some extra resources, loss of income or the emergence of additional costs on one side and the possibility of obtaining significant benefits (income) as a result of carrying out a purposeful activity on the other.

The impact of the risk is usually related to the cost, schedule and specifications of the product or service being developed. Risk exposure may cause the product or service to cease to satisfy the customer’s demands in one way or another. Impact often has a validity period from the moment the risk is realized to its disappearance or elimination. Usually some conventional units or a qualitative scale (such as small, medium, large, etc.) are used to assess the impact of the risk.

Likelihood of risk is the likelihood that a given risk will become an event that will turn into a problem. A specific qualitative scale associated with numerical values should be applied here.

It is advisable to identify risks before they become a problem. Once the risk has been identified, the appropriate action must be planned. The task of the project manager is to select such actions that will reduce the likelihood of adverse events or reduce their consequences if they take place. However, it is desirable that the cost of resources throughout the corporate project management system be minimal.

Commonly the following risk management directions are used.

1. Avoiding risk. Reorganize the project so that it does not depend on the event. For example, when designing products, you can exclude functionality that is doubtful. But this narrows the functionality of the product or service provided.

2. Risk redirection. The customer insures the contract against non-fulfillment of its terms by the contractor, and the contractor against violation of the payment terms by the customer.

3. Risk consent. This does not mean that nothing should be done while passively waiting for the risk to be realized. By accepting the presence of risk, definite measures can be taken to reduce the likelihood of it occurring, reduce its effects, or develop a plan of alternative action to be taken in case of the risk occurrence.

When choosing a particular risk management way, one should pay attention to the fact, that the effects of the risks and the actions to avoid or mitigate them, for one of the projects, can have a significant impact on the implementation of other projects. This is especially important when considering the implementation of resource-related project groups (portfolios and programs). The most important task in risk management is to identify the risks that require preliminary preparations to manage them. Such preparations should be reflected in the development of response measures.

The list of risk events requiring the development of response measures should be documented in the project passport as the primary document describing the basic data and approaches for the project implementation.

Developing response measures is the definition of actions that must be taken to reinforce the positive effects of occurrence of risk events and to mitigate the negative ones. The list of such response

measures is the basis of risk management. It is advisable to include in the project passport risk management measures, responsible persons, deadlines and periodicity of risk monitoring.

Possible risks of the project have a well-developed hierarchical structure, which is shown in Fig. 7.1. This structure shows that most of risks can be taken into account in some way or another at the project planning stage. The purpose of prior risk planning is to carefully assess the impact of the risks on the timing and cost of the project. At the pre-planning stage, potential risks are analyzed. This analysis is very important for evaluating project performance.

The most common risk categories are:

– risk of increased project costs (increased workload);
– risk of delays in the tasks execution (increase in the time of task execution);
– risk of late delivery of equipment;
– risk of payment delays by the project investor or lender.

These risks determine the deadlines and cost of project work.

The timing and cost of project may be affected by risks that relate to future conditions or circumstances. Not necessarily but they can have a negative impact on project timelines and costs. The appearance of the risk signs, taken or not into account in the preparation of the preliminary plans of the project, is an absolute signal to analyze their possible impact on the current state of the project and to apply the compensation measures to reduce their negative results.

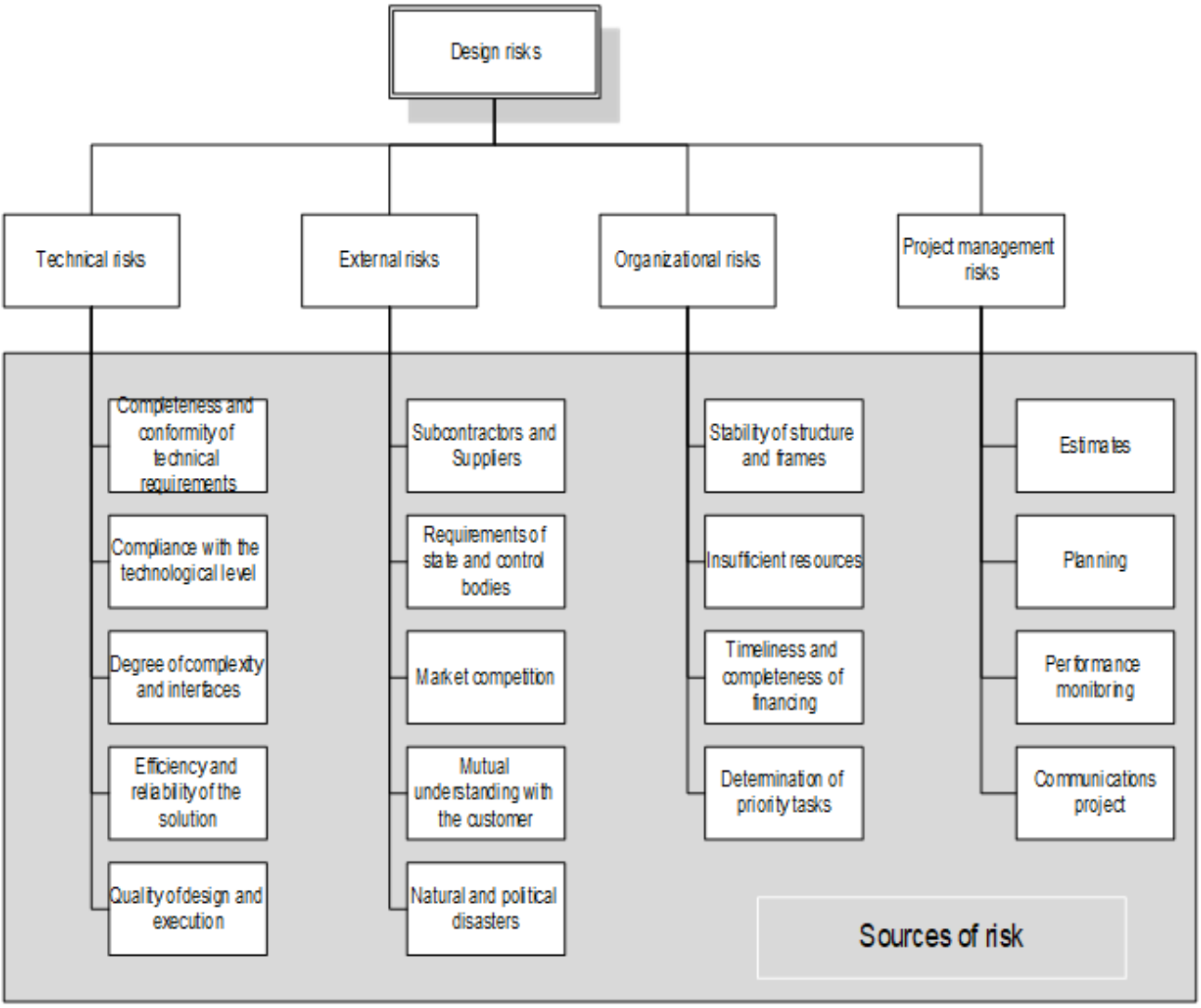

Fig. 7.1. Risk groups and sources of their occurrence

Risk is a potential problem of the project, the occurrence of which is random. Not all problems can be eliminated and even anticipated in advance, but many problems can be foreseen, and this makes risk management possible.

Risks can be divided into internal and external to the project. Internal risks are those events that the project manager and the project management team are able to influence. External risks do not depend on either the project manager or the project management team.

Risk planning consists of the following steps:

- risk identification;
- risk assessment;
- developing response to those risks that require it.

Risk identification is to determine what risks are likely to affect a particular project and other related projects within project portfolios or programs. Risk identification should be carried out throughout the life of the project. The purpose of risk identification is to list the risk events that may affect the project (the impact of the risks can be negative and positive). Risk identification is not a activity done once, it should be done regularly.

Risk assessment is performed in terms of their impact on the progress and results of the project [16]. The purpose of such analysis is to determine which risk events require the development of response measures and which ones do not. In order to reasonably address such issues, each of the project risks should be considered to assess the likelihood of their occurrence and impact on the project and other related projects, portfolios and programs. Risk assessment can be performed using qualitative levels or quantitative indicators.

Project risk management includes:

- search and identify foreseeable risks;
- risk analysis and assessment;
- choice of risk management methods;
- application of selected methods and decisions in risk conditions;
- responding to the risk event;
- development and implementation of risk mitigation measures;
- control, analyze and evaluate risk mitigation and decision-making.

Among the risk management methods, the most common are:

- development and implementation of risk management strategy;
- risk compensation methods, including project environmental projections, project and product marketing, environmental monitoring and project reserve system creation;
- risk localization methods used for large and complex projects by special teams of risk analysts;
- risk avoidance methods, including the abandonment of risky projects and unreliable partners, risk insurance, search for guarantors.

The probability of risks occurrence and the magnitude of losses can be estimated as some discrete values, which are determined in accordance with the breach of the terms of reference at the date of the project status assessment, which can be defined by such parameter as the risk index.

The risk assessment should reflect the cumulative average relative timing violations of all tasks performed at the time of assessment of this impact. It can be assessed and determined by calculating the average of the tasks time disruption due to the risk event across all tasks performed at the time of assessment, in percent. This assessment will thus be determined as the ratio of the time divergence to the planned execution time for all tasks, having nonzero divergence, among those that must be executed at the moment.

Let us define the variables as:

k – number of tasks performed at the time of risk assessment;

dpi – is the start date of the task i performed at the time of the risk assessment;

dзi – date of completion of the task *i* performed at the time of risk assessment;

dвi – date of submission of performance data of the task i performed at the time of risk assessment;

doi – date of risk assessment;

pвi – percentage of completion of the task *i* at the date of data submission.

The percentage of completion of the i-th task at the risk assessment date, as determined by the input data, can be defined as:

$$poi = pвi * (doi – dpi)/(dвi – dpi).$$

The percentage of completion of the i-th task at the date of the risk assessment according to the plan can be defined as:

$$pni = (doi – dpi)/(dзi – dpi) *100.$$

Then. $$x = \sum_{i=1}^{k} (pni - poi)/k .$$

Only for those tasks, where *poi* < *pni.*.

The classification of risks by likelihood of occurrence can be determined on the basis of a division into five levels, which reflects in sufficient detail the various possible situations in the risk analysis. An example of this division is given in Table 7.1, where a point estimate of the likelihood of a risk arising from the evaluation of information on the project execution objectives is identified.

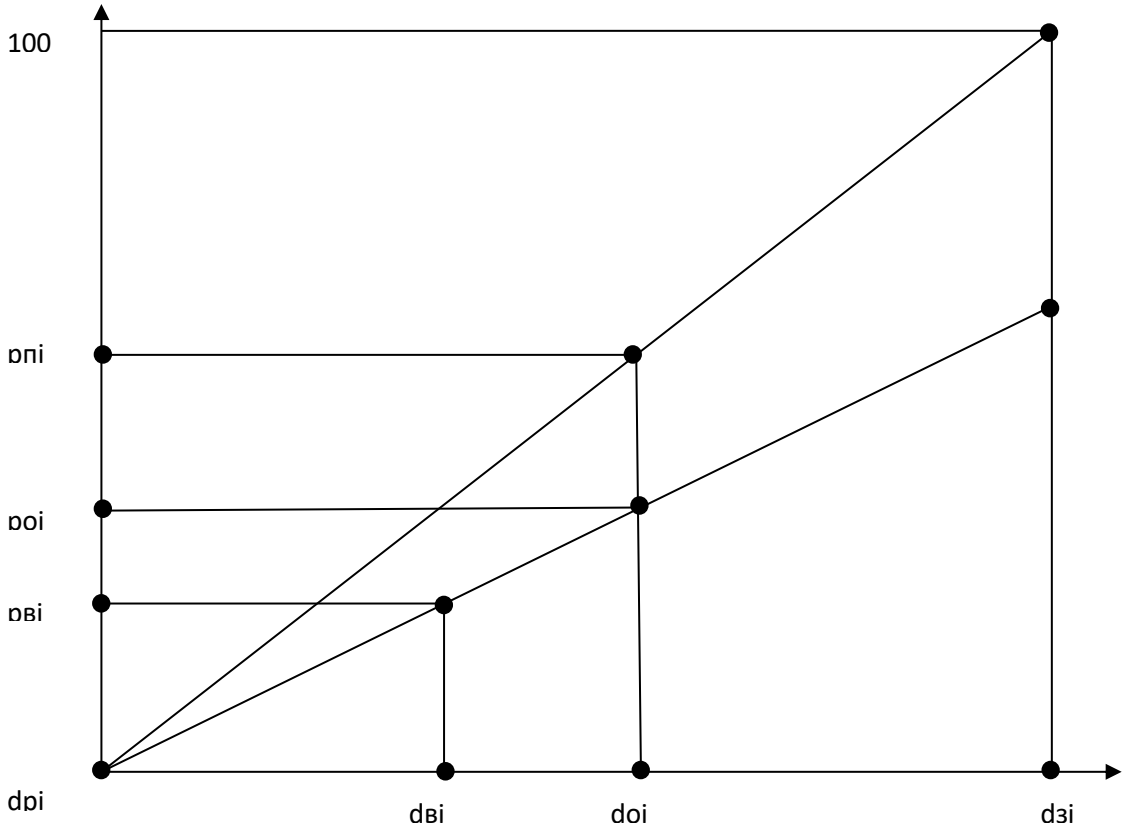

Fig. 7.2. Determination of values of percentages of fulfillment of project tasks according to the submitted data and plan

Table 7.1. Score of risk likelihood based on project implementation status

Occurrence probability	
I (points)	(%)
1	0% < x ≤ 10%
2	10% < x≤ 30%
3	30% < x ≤60%
4	60% < x ≤90%
5	90% < x≤ 100%

The loss value should reflect the overall relative time divergence across the project as a whole. An estimate of the loss value can be made by determining the value of the greatest possible impact on the individual tasks performed at the time of the risk assessment at the finish time for the entire project.

The estimated percentage loss based on an analysis of the project status at the time of the risk assessment can be determined as follows:

$$y = max((pni – poi)*(dзi – dpi))/dp$$

where, *dp* is the planned duration of the whole project.

Only for those works where *poi < pni.*.

Using this value, a point estimation of the possible losses from the risk is carried out according to the results of determining the status of project tasks.

Table 7.2. Point estimation of risk losses value on the results of determining the status of project implementation

Loss	
B (points)	(%)
1	0% < y ≤ 10%
2	10% < y ≤ 30%
3	30% < y≤60%
4	60% < y ≤90%
5	90% < y ≤ 100%

The risk index value can be used to assess the possible impact of risk on the project status.

The risk index is an indicator of the estimation of probable loss in points, which makes it possible to assess the degree of action and the level of risk threat.

The risk index is estimated using the formula:

$$R = I * B,$$

where:

R is the risk index

I=f1(x) is the probability of occurrence of risks according to Table 7.1 (in points).

B=f2(y) is the value of losses according to Table 7.2 (in points).

f1, f2 are given tabular functions that determine the transition from the calculated values of x and y estimates to the integer point estimates.

The evaluation process during project is based on the assessment of the degree of risk exposure for each of the possible risks according to the current value of the risk index (the value of R for each of the risks at the current time of the project implementation status analysis).

Depending on the risk index value obtained for each of the possible risks, an assessment of the need and form of response to the impact of the risk is carried out (Table 3). In justified cases, estimates of the cost or duration of the project tasks may be adjusted by the amount of risk associated with those tasks.

Table 7.3. Impact of risk and response to it

Risk Index (R)	The degree of risk exposure	Risk categories	Response to risk
$1 \le R \le 4$	No impact Absence of any influence on the project.	Acceptable risks They are defined as risks that do not require immediate reaction but can be noted for further analysis.	Acceptance of risk Provide risk acceptance. Acceptance can be active (in the pre-development of risk events) or passive, in which it is sufficient to simply predict cash, time reserves or reduced profit in the plan.
$5 \le R \le 8$	Minor impact Increased duration of task, the amount of additional work within the budget and planned completion dates; production defects are minor.	Risks justified Secondary processing. Each risk with this level should be taken into account when performing the task. The presence of such risks requires that certain actions that will reduce the risk impact on the final results of the project are to be done. The risk should be kept under constant control and its level should be re-evaluated periodically.	Impact reduction Need to reduce the impact of risk by reducing the likelihood of a risk event. This can be achieved, for example, by prevention measures that reduce the likelihood of risk. You can reduce your risk losses through insurance, duplication or other measures.
$9 \le R \le 10$	Moderate impact Increased duration of work, noticeable manufacturing defects, non-compliance with technical solutions, the amount of additional work require approval with the Project Sponsor.		
$12 \le R \le 16$	Significant impact Increase in the tasks duration, production defect, non-compliance with technical solutions, the amount of additional work is not acceptable to the Sponsor.	Unacceptable risks Primary for processing. Actions to eliminate the impact of such risks should be taken in the first place. Reducing their impact, as a rule, requires the intervention of management to gain additional resources for project (labor, financial, material, etc.).	Risk elimination They need to eliminate the risk by eliminating its potential cause. In some cases it is possible. For example, you can eliminate the risk of different understanding of quality requirements by the customer and the supplier, by clearly formulating these requirements in the text of the contract
$20 \le R \le 25$	Critical Impact Extreme degree of violation of the plan and technical requirements for the project.		

This approach to the degree of impact of risks on the final results of project assessment makes it quite easy to implement it as an add-on to standard software.

It is important not only to identify the potential risks of the project, but also to evaluate their impact on the results, to make timely decisions on risk reduction, and to carry out risk management at all stages of project and to adequately document the processes of project risk management for further application of this knowledge in the future practice of managing such projects.

Questions to Section 7.

1. What is project risk management?
2. How is risk identified in the project?
3. What is the risk probability?
4. What are the areas of project risk management?
5. What are the risk categories?
6. What does project risk management involve?
7. How can risks be classified by probability?

8. CONTROL OF PROJECT IMPLEMENTATION

Control of project implementation

There are two components of the project controlling:

- organization and control of project;
- analysis and regulation of project execution.

Organization and monitoring of project performance (Project Performance) - organization of tasks included in the project plan and control their execution.

Project Controlling is a process of comparing actual execution to planned one, analyzing deviations, evaluating possible alternatives, and taking corrective actions, if necessary, to eliminate unwanted deviations from the baseline.

Organization and control, analysis and regulation are complex management processes. In addition, this is the most costly part of the project, because at these stages the product is created. These stages are characterized by increased consumption of resources (approximately 80% of all resources) [17].

Organization and monitoring of project is usually considered as the organization and controlling of the tasks included in the project plan execution.

Organization and control of project includes:

- organization of project subject area management;
- control of project execution by time parameters;
- organization and control of project execution by cost;
- organization and execution of quality control;
- operational management of risk mitigation measures;
- improving the project team;
- distribution of information;
- organization and preparation of contracts in the project;
- organization of change management in the project.

The main purpose of project control is to ensure that targets are met and to increase the overall effectiveness of project planning and control functions.

The task of the project control is to determine the results of the activity on the basis of evaluation and documentation of actual performance indicators and compare them with the planned indicators.

Principles of building an effective control system:

- availability of specific plans;
- availability of an informative reporting system;

- having an effective analysis system of actual indicators and trends;
- having an effective response system;

Objects of control:

- content changes;
- timetable;
- costs;
- quality;
- risks.

Monitoring is the control, monitoring, accounting, analysis and reporting of the actual implementation of the project compared to the plan [18].

Monitoring methods:

- simple control method (0% and 100%);
- method of detailed control;
- method 50/50 (the degree of completion is determined when 50% of the budget is spent);
- milestone method.

Analyzing and regulating project execution is the process of comparing actual execution to planned, analyzing deviations, evaluating possible alternatives, and taking corrective actions, if necessary, to eliminate unwanted deviations from the baseline.

Analysis and regulation of project implementation includes:

- analysis of the status and regulating the subject area of the project;
- analysis and regulation of the project by time parameters;
- analysis and regulation of the project by cost indicators;
- status analysis and quality assurance;
- risk analysis;
- analysis of the activities and development of the project team;
- analysis of communications during project implementation;
- control and regulation of contracts;
- analysis, integration and regulation of changes in the project.

During project monitoring, the manager needs to be able to determine whether the project fits into the planned budget and whether it will be completed within the scheduled time period. For this purpose it is necessary to collect the actual data on the tasks execution - it is necessary to analyze them properly. For this purpose the method of the mastered volume can be used.

Method of developed volume

In the method of the developed volume 3 quantities are used to determine the status of the project:

- BC Planned (Budgeted) Expenses-BCWS (Budgeted Cost of Work Scheduled). This is the budgeted cost of the works scheduled according to the schedule or the resource amount estimated to be used up to the present date [19].
- Actual Cost - ACWP (Actual Cost of Work Performed). This is the cost of the work actually completed on the current date or the amount of resource actually spent on the work to date.
- Spent Volume - BCWP (Budgeted Cost of Work Performed). This is the estimated cost of the work actually completed or the amount of resource scheduled to actually complete the work up to the current date.

Various combinations of these indicators allow to determine the lag / advance of the task execution according to schedule and cost / savings of the project budget.

The main options for decision-making and activities are:

- find an alternative solution;
- cost revision;

- revision of terms;
- revision the content of tasks;
- termination of the project.

Questions to Section 8.

1. What are the stages of monitoring project execution?
2. What is involved in organizing and monitoring project execution?
3. What are the objects of project control?
4. What is project monitoring?
5. What does the analysis and regulation of project execution involve?
6. What is the developed volume method?

9. CORPORATE PROJECT MANAGEMENT SYSTEM

The Corporate Project Management System (CPMS) includes:

- project management methodology;
- methods of solving individual problems;
- tools and software;
- requirements, regulations and procedures for the work execution in the CPMS;
- elements of an organizational structure that are integrated into a single purposeful system that are used to manage both individual projects and groups of projects (project portfolios and programs) [5].

The CPMS defines the systematic and process-based approaches to project management that apply to all enterprise projects, as well as the knowledge, skills, tools, and methods that are used in the processes and procedures implemented within project management.

The CPMS includes only those basic elements of the organizational structure involved in the project management process, the role and function of the personnel involved in the project management, and the formalized relationships between the participants in the process.

The main components of the enterprise CPMS can be divided into three groups:

- **methods and methodology of the project management system** and, as the main document, the corporate standard of project management;
- **staff** - a group of people who has the appropriate training in project management, acts in accordance with uniform rules and solves tasks that are regulated by these rules (standards, regulations and orders);
- **tools** - software and hardware tools for the automated environment, which creates a single information space for project participants and ensures the implementation of the enterprise project management methodology.

The implementation of the CPMS should be planned in areas that reflect the main types of project activities.

In terms of implementation and development of the CPMS, the following areas should be defined:

- Methodological support (for example, provisions on work in the CPMS, rules of engagement, concepts, regulations, standards, etc.).
- Software (includes implementation of standard software, such as MS EPM and development of custom software).

- Organizational support (among the most important tasks is the deployment of the project office, as an organizational unit of the enterprise, the development and approval of regulatory documents).
- Administrative measures (development of orders for initiation and organization of project activities, motivation of participants of CPMS at all levels, etc.).
- Training - organizing and conducting training in units on the appropriate levels of project responsibility and project management roles.
- Dissemination of experience (holding meetings, seminars, conferences, Web Portal, CPMS knowledge base, etc.).

One of the main approaches in the implementation of project activity is the complete and comprehensive standardization of project activity, the main elements of which is the corporate methodology of project management.

Corporate project management methodology is a set of procedures and internal regulatory documents that determine the composition and content of these procedures, as well as a set of project management tools and methods that ensure the execution of all enterprise projects according to uniform rules and standards.

The corporate project management methodology defines the management procedures (decision making and rejection of project decisions) at different phases of the project life, and the requirements for projects in different functional areas: finance, personnel, terms, resources, risks, quality, supply and more.

Corporate project management methodology is determined by the production and structural features of the enterprise.

The software used to support project management processes is selected according to the requirements of the corporate project management methodology.

Corporate project management methodology should be established within the framework of the development of the CPMS as an element of the enterprise activity. The tasks of development and implementation of corporate methodology should be solved within the organizational constituents of CPMS at all stages.

The organizational and functional elements of CPMS are [20]:

- project office (as a unit in the enterprise structure - for example, project management department);
- project management team as a temporary unit that ensures the execution of one specific project, for which it was initiated).

The Project Office (**PO**) is a separate unit of the enterprise that performs the tasks of organizing project management, preparation and implementation of methodological, software and training project management throughout the enterprise.

The main goals of creation:

- development, implementation, support and development of methodology and common standards for project management and reporting in the enterprise;
- implementation and support of the enterprise-wide system of training and retraining of employees for effective participation in the project activity;
- allocation of limited resources between projects, resolution of controversial issues;
- implementation of a unified system for informing stakeholders about the progress of project work;
- organization of the knowledge base;
- creating new projects and archiving of completed projects;
- implementation of procedures for effective monitoring and control of planning and execution in order to optimize work on projects throughout the enterprise.

The main functions of the software in CPMS:

- participation in the analysis and selection of projects for implementation;
- verification of compliance of the project passport with the existing corporate standards;
- monitoring the progress of project execution;
- preparation of planned and unplanned reports to the enterprise managers;
- reviewing, analysis and preparation of approval of requests for changes in projects;
- organization and maintenance of the document flow between the project office and other project participants;
- maintaining the projects register;
- archiving of completed and closed projects;
- creating a knowledge base (templates, methods, etc.);
- project audit;
- timely updating of the project methodology;
- development and support of workflow procedures;
- development of the reporting procedure;
- development of regulations on project document flow;
- development of a regulation on the archiving of completed and closed projects;
- organization of consulting and troubleshooting of the software usage;
- organization of training and retraining of employees for effective participation in project activities;
- organizing and conducting seminars and meetings to disseminate project implementation experience.

Project Management Teams (**PMT**s) are temporary entities that are created to manage the execution of each specific project on the submission of the Head of Software and in agreement with the Head of Unit to which the project relates.

The main functions of the PMT are:

- preparation of project passport and other necessary documentation;
- monitoring the compliance of the project plan execution;
- operational monitoring of the project execution progress;
- preparation of regular operational progress reports;
- maintaining a single standard and methodology for project management and reporting;
- allocation of limited resources between projects, resolution of controversial issues;
- preparation of requests for changes in the project and making of the authorized changes;
- execution of project workflow;
- preparation for archiving of completed and closed projects;
- preparation of reports on completed and closed projects;
- request and involve missing resources.

The ***Project Registry*** is a basic, ordered and complete information repository, which should provide complete information on all types of projects that have been carried out, are being executed and may be maintained within the CPMS [21].

The project description structure in the registry should provide complete and accurate project information. However, the information completeness of the project description in the register depends on the structure of the register and therefore this structure should be sufficient in content and volume.

The reliability of the information, however, depends entirely on the subjective factor and should therefore be verified through a scheduled audit. The Project Register is a dynamic structure that reflects the list of projects according to their current position in the project portfolio. The project registry also allows the creation of project folders, the composition and content of which is directly generated by the CPMS users according to their needs and roles.

The composition of the project registry may be modified and supplemented in accordance with current needs and tasks assigned to the CPMS.

To create, analyze and control the process registry, special software tools are used to control the progress of individual projects, project portfolios and project folders.

Portfolios and project folders are aggregated project groups that have a number of characteristic features. The main characteristics and features of project portfolios and folders are shown in Table 9.1.

Table 9.1. Aggregated project groups

	Features aggregated project groups	**Types** aggregated project groups	
1	**Types** groups of aggregated projects	**Project portfolios** of a group of projects with a hierarchical structure	**Project folders,** groups of projects that are linked by certain features
2	**Signs,** used for aggregation	**The administrative structure of the enterprise -** the relation of projects to the elements of structure	**Unstructured features** and their combinations
3	**Results** aggregation	**Static -** fully linked to the enterprise outline	**Dynamic -** appear and exist only when needed to analyze the progress of a particular group of projects
4	**Periodicity** forming groups	**Dynamic -** appear and exist only when needed to analyze the progress of a particular group of projects	**If needed -** as the need arises for a particular analysis
5	**Term** the existence of aggregation results	**Permanent -** with updates as new projects emerge	**Temporary -** until the end of the analysis and the need for its results
6	**Form** aggregation results	**Real portfolio** of projects implemented by the company and accompanied by the CPMS	**A virtual project** folder that is an aggregate group built on certain features

The following graphic description of the business process support model for project execution (Figure 9.1) describes the composition and sequence of execution of the most important tasks for the main groups of contractors of these works.

To reduce the size of the description in this graphic model, all roles, both for the project office and the PMT, are grouped. The role of the project office (software) combines the roles of the project manager, manager and administrator, and the PMT U role integrates the roles of the manager and the PMT members.

The model reflects only the most important steps and groups of work to be undertaken in the project support process. A more detailed and complete model for the process of support for project execution in the CPMS should be described in an appropriate manner (regulation), which includes both a description of the sequence of tasks with reference to their contractors and the samples and templates of documents used in this process.

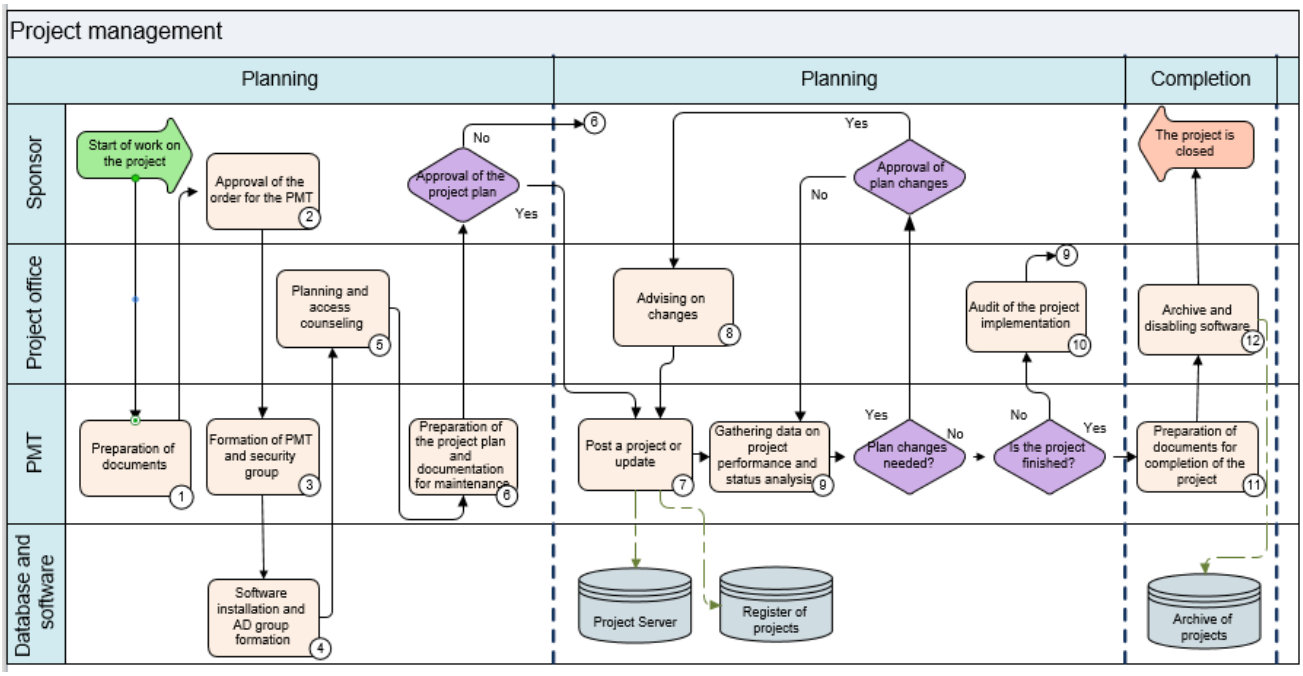

Fig. 9.1. Graphical model of project execution support (example)

In the process of supporting the project execution, as shown in the example, the following basic steps are identified (Fig.9.1):

1. The project manager prepares:

- project argumentation (if necessary for corporate projects);
- an order to create a PMT for a specific project (if necessary for complex projects).

The prepared project argumentation and the order to create the PMT are submitted to the sponsor (responsible for financing) for approval of the project and the management.

The functions of the PMT members may be fulfilled within the authority of the administrative units without the creation of appropriate orders.

In case the PMT is not created, all its functions are performed by the project manager.

2. The project sponsor (management of the company) approves the order for PMT, if necessary to create such a unit for the project, from the employees of structural units with partial or complete freeing from their job functions for the period of the project.

The order sets out the main objectives of the project, the timeframe, the manager, the project coordinator, a list of the main PMT members who are to fulfill the project's tasks specifying, if necessary, specific functions and roles. These role assignments can be determined later by specifying the project passport and communication program.

3. The project manager or the coordinator authorized by the project manager is to hold the necessary meetings with the PMT members and provide clarification and instructions on the project execution.

4. STP employees responsible for the maintenance of MS Project software install MS Project software and create groups in AD (active directory), if necessary.

5. The Project Office (PO) grants project access rights to the Project Server for PMT members and advises PMT members on document processing:

– detailed project plan;
– feasibility study of the project (if necessary);
– project passports (if necessary);
– communication plan and project reporting (if necessary).

6. The project manager or the coordinator authorized by the manager together with the PMU members prepares the project schedule and other documents necessary for the project management and submits them for approval to the project sponsor (company management).

7. The PMT manager or the coordinator authorized by the manager is to publish the agreed (or modified and updated) project plan on Project Server using MS Project Professional.

8. The project office advises to make changes in the project, if necessary.

9. The PMT leader and members regularly submit work progress (cycle) in accordance with the approved communication plan and project reporting.

The main stages of these works are:

- gathering up-to-date data on the status of project from responsible for the tasks of PMT members;
- reporting in accordance with the project communication plan, procedure and periodicity of reporting to PMT members;
- analysis of the current status, risks and preparation of operational information on the necessity of changes to the project.

If changes are required, a change list is prepared and submitted to the sponsor for approval, otherwise a check is required to complete the project.

If the sponsor agrees on the necessity of changes, the project office recommends the correct changes to the project in progress.

10. If the project is not yet completed, the software shall carry out an audit of the project execution, an analysis of the current results and the relevance of existing information on the project execution at the request of the project sponsor, management or regulatory documents.

11. PMT prepares documents for project closure (completion). The project manager is responsible for preparing the closing and archiving documents. The final project execution report is provided to the project sponsor.

12. The software archives the completed project at the request of the project manager. The archived project plans are used as prototypes and templates for subsequent projects.

***Features of implementation of* CPMS**

According to PMI research, the creation and deployment of a permanent CPMS in most organizations takes from six months to two years. The following factors are most likely to have a significant impact on the time and success of the implementation of CPMS in an organization [17]:

- fuzzy vision of the CPMS model, its scope and results which are to be obtained from the company management and the project manager;
- insufficient support from the organization's top managers;
- the insufficiently competent staff of the CPMS if they are appointed to the CPMs from the current enterprise stuff;
- insufficient resources are allocated to create the CPMS and to create the necessary infrastructure for the office to perform its functions.

One of the key indicators in evaluating the success and effectiveness of the CPMS is the value it generates through the ongoing processes for stakeholders such as organization headquarters, project beneficiaries, and project managers. As a rule, the opinion of project managers is decisive in evaluating the value created by the CPMS for the organization. If the CPMS does not provide them with the support they need to solve problems and implement projects more effectively, then other stakeholders tend to think that the value of the CPMS is low. In this regard, since the decision to establish a CPMS, the CPMS manager should define key CPMS stakeholders and permanently study and manage their expectations of the CPMS throughout the life cycle of the CPMS, ensuring the provision of valuable services to them at an agreed quality level.

Questions to Section 9.

1. What is a Corporate Project Management System (CPMS)?
2. What are the main components of the CPMS?
3. What are the organizational and functional elements of CPMS?
4. What are the functions of the project office?
5. What are the main functions of the PMT?
6. What does the project registry include?
7. What are the aggregated project groups?

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A D D I T I O N S

Addition 1

Features of the standard ISO 21500

In 2012, an ISO 21500 project management standard was published, currently approved by the US and the European Union. This standard is much shorter than the previous ones, but considers the project not only as a separate activity, but also as an integral part of the overall activity of the organization, as well as larger entities such as portfolios and programs.

The objectives of ISO 21500 are to provide top management with information on project management principles and practices, to provide project managers and project team members with current standards and practices, and to provide national and corporate standards developers with a basic document.

This International Standard is a general guide to project management concepts and processes that have a significant impact on project results.

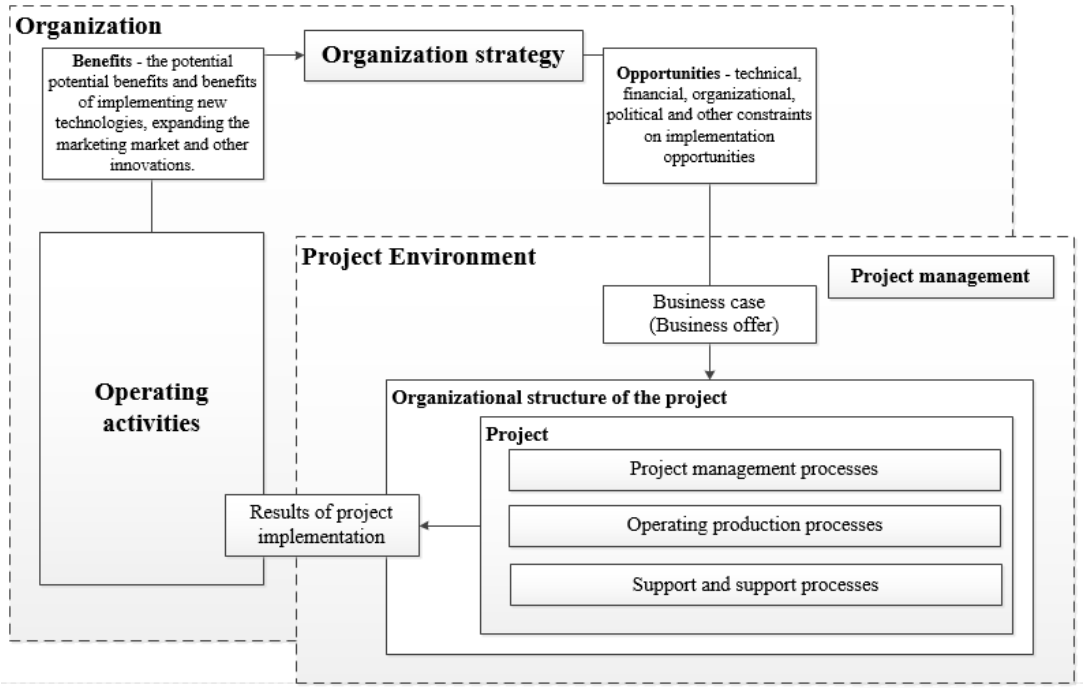

Fig. 10.1. Relationship between project management concepts

The target audience is top executives and project sponsors, project managers and project team members, as well as national and corporate standards developers.

In this standard, project activities are closely linked to the strategy and operational activities of the entire organization.

Figure 10.1 shows how project management concepts are interrelated. Organizational strategy identifies opportunities. Opportunities are evaluated and should be documented. The selected opportunities are further developed into a business plan or other similar document, on the basis of which one or more projects producing results are initiated. These results can be used to receive benefit. Benefit can be used as an input parameter for implementation and further development of organizational strategy.

Organizations endorse a strategy based on mission, vision and policy. Of course, projects are aligned with strategic goals. Figure 10.2 shows a typical project portfolio management cycle from strategy to benefit.

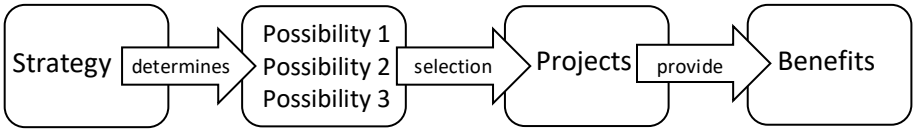

Fig. 10.2. Project portfolio management from strategy to benefit

In ISO 21500, a project is defined as a unique set of processes that includes coordinated controlled operations with a start and end date that are completed to achieve a goal.

Any project has a definite beginning and end. Usually the project is implemented through a sequence of phases.

Further, the standard defines project management as the application of methods, tools, techniques and competencies to the project. Project management involves the integration of different phases of the project lifecycle.

The processes selected for use in the project are built on a systematic basis. The results of the project are regularly evaluated during its implementation to meet the requirements of the curator, customer and other stakeholders.

Based on the current capabilities of the organization, a list of capabilities can be developed. These capabilities can be evaluated to support informed decision-making by management to identify projects that could turn some or all of these capabilities into benefits.

Such capabilities may meet, for example, new market needs, current organizational needs, or regulatory requirements. Usually, organizations find and appoint a project curator to balance project goals and benefits.

Project goals and benefits are achieved by defining project investments, for example, in the form of a business plan, and this can be a basis for choosing priorities when choosing opportunities. The task of defining investments is to approve the investment management of the project.

The evaluation process may include many criteria, including investment and quality assessment, such as compliance with strategic goals, social value or environmental impact, and may differ for different projects.

Realization of benefits is the responsibility of the management of the customer's organization, which can use the project results to obtain benefits in accordance with the organization's strategy. Project manager must consider benefits and their realization as they will influence decision making in the project life cycle.

The project team should consider the following:

External factors outside the parent organization - socio-economic, geographical, political, legal, technological and environmental situation.

Internal factors within the parent organization are strategy, technology, project organizational maturity and availability of resources, corporate culture and organizational structure.

The project is usually carried out within an organization covering other activities. In such cases, there is a relationship between the project and its environment, business planning and operational activities. Pre-project and post-project activities may include activities such as the development of a business plan, feasibility studies and the transfer of project results to operational activities. Projects can be organized within programs and portfolios.

A project portfolio is a collection of projects, programs and individual works that are grouped together to facilitate effective management to achieve the strategic goals of the organization. Project Portfolio Management is the centralized management of one or more project portfolios, which involves identifying, prioritizing, approving, managing and controlling projects, programs and other work to achieve specific strategic goals.

It may be appropriate to identify and select opportunities, approve and manage projects through an automated project portfolio management system.

A program is a group of related projects and individual works that meet strategic or other important goals. Program management is a centralized and coordinated effort to achieve these goals.

In addition to project management, the standard distinguishes external project management, which includes aspects such as defining the governance structure; the policies, processes and methodologies that will be applied; limitations in decision-making powers; responsibility and accountability of stakeholders; interactions such as reporting and escalating problems or risks. The organization functions to achieve specific goals. In general, all activities of the organization can be divided into design and operational. Operational activity differs from project activity in that it is carried out by relatively constant teams during repetitive processes and is aimed at maintaining the viability of the organization. Projects are implemented by temporary teams, do not repeat and produce unique results.

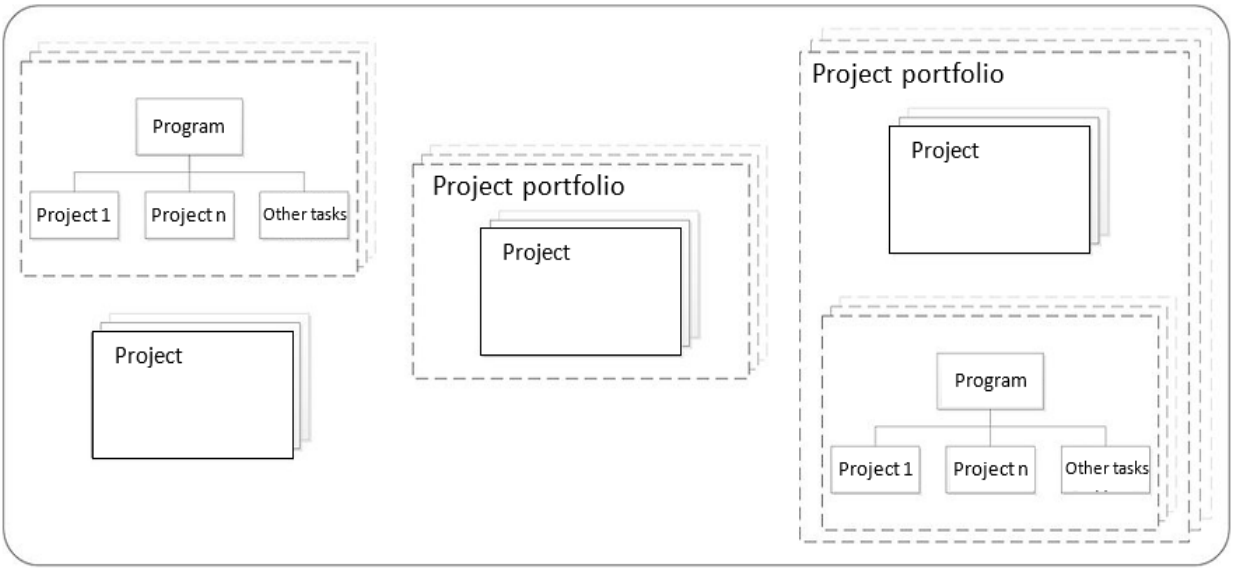

Fig. 10.3. Projects, programs and project portfolios

In addition to the team itself and the project management, there are a number of project participants who are commonly referred to as stakeholders. In order to increase the likelihood of project success, project stakeholders, including the project organization, should be described in sufficient detail. Stakeholder roles and responsibilities can be determined in relation to the goals of the project and organization. The standard project stakeholders are shown in fig. 10.4.

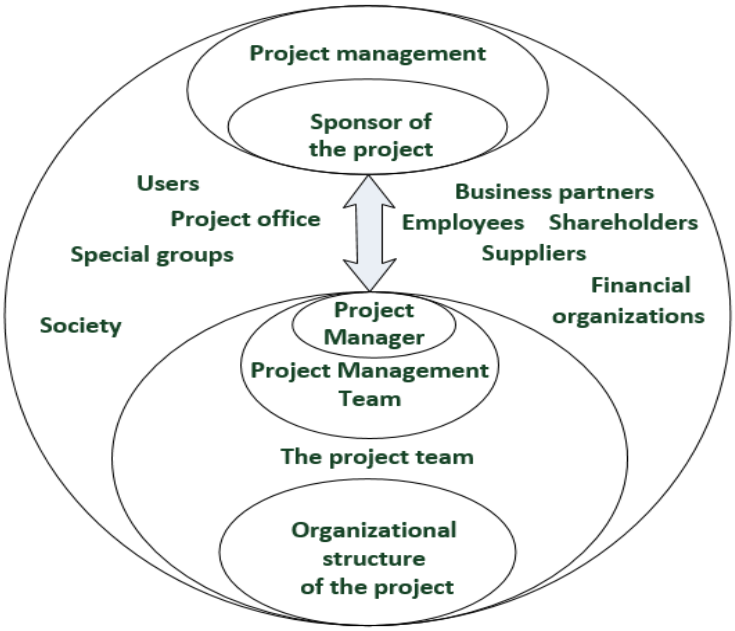

Fig. 10.4. Project Stakeholders

A project structure is a temporary structure that includes the roles, responsibilities, boundaries, and level of authority within the project that must be identified and communicated to all project stakeholders. The project structure may depend on legal, commercial, interagency or other agreements that exist between project stakeholders and may include the following elements:

- project manager – manages and controls the execution of the project and is responsible for achieving the project results;
- project management team (if necessary) - assists the project manager in managing and controlling project and achieving project results;
- project team - executes project tasks for successful completion of the project.

External project management by the Client (Project governance) may include the following persons:

- Project Sponsor - manages, approves project start-up, allocates resources, facilitates and ensures project implementation. Makes executive decisions and resolves issues and conflicts that fall outside the authority of the project manager.
- Steering Committee or Board (if necessary) - Contributes to a project providing top management for the project.

Figure 10.4 includes the following additional stakeholders:

- Customer or customer's representative - contribute to the project by formulating project requirements and approves project results;
- Suppliers - Contribute to the project by providing resources for project implementation;
- Project office - can carry out a wide range of activities including management, standardization, project management training, project planning and monitoring.

An essential issue that determines the success of the project is the competence of the project participants. Improvement of competence is achieved through training, coaching and mentoring inside or outside the organization.

Projects are usually organized into phases that are determined by management and control demands. The project phases make up the project life cycle. The project life cycle covers the period from the beginning of the project to its end.

For each project there is a list of restrictions within which it is implemented.

There are several types of constraints and, as constraints are often interdependent, it is important for the project manager to balance those constraints. Project outputs must meet project requirements and meet constraints such as content, quality, timeframe, resources and cost. Restrictions are usually interrelated so that changing one can affect one or more other constraints. Thus, constraints can affect decisions made within project management processes.

Consensus among key project participants on constraints can form a solid foundation for project success.

This standard specifies recommended project management processes that can be used during the execution of a project as a whole, in its separate phase, or both. These project management processes are suitable for projects of any organization. Project management requires significant coordination and, as such, requires that each process be verified and linked to other processes to ensure the success of the entire project. Some processes may be performed several times to more fully identify the requirements of the stakeholders and align the project objectives.

Project managers, together with other project stakeholders, are advised to carefully study the processes outlined in ISO 21500 to apply exactly those processes that are relevant to the project and the needs of the organization.

Project management processes can be considered in two different perspectives: from the perspective of project management (process groups) and in terms of grouping processes by subject domains (subject groups). These two different groups are presented in Table 10.1. The processes themselves, regardless of grouping, remain unchanged.

Table 10.1. Relevance of project management processes to process groups and subject groups

Subject groups	Process groups				
	Initiation	Planning	Implementation	Management	Completion
Integration	Development of project charter	Development of project plans	Direct work on the project	Project work management	Closure of a separate phase or project
				Change management	Knowledge received
Stakeholders	Identifying stakeholders		Stakeholder management		
Content		Determining the content of the project		Project Content Management	
		Creating a work breakdown structure (WBS)			
		Determination of the task composition			
Resource	Creating a project team	Resources evaluation	Project team development	Resource management	
		Defining the organizational structure of the project		Project team management	
Time		The sequence of tasks		Schedule Management	
		Estimated task duration			
		Schedule development			
Cost		Cost estimation		Cost Management	
		Budgeting			
Risks		Identifying risks	Attitudes to risks	Risk management	
		Risk assessment			
Quality		Quality plan	Ensuring quality requirements	Quality management	
Supplies		Supply plan	Choice of suppliers	Administration of contracts	
Communi-cations		Communication plan	Dissemination of information	Communication Management	

Initiating process group is used to start a project or project phase, to determine the purpose of the phase or project as a whole, to empower the project manager to begin work on the project.

Planning process group is used for detailed planning. Detail level should be sufficient to establish a baseline against which project implementation is monitored.

Implementing process group is used to execute project management tasks and to achieve the results identified in the project plan.

Controlling process group is required to track, analyze and adjust the progress and effectiveness of project implementation as planned. Therefore, if necessary, preventive and corrective actions can be taken and requests for changes made to meet project goals.

Closing process group is performed to formally complete the project or phase and analyze the accumulated knowledge in order to apply it in the future.

Project management begins with the initiation process group and ends with the completion process group. The interdependence between process groups requires the interaction of a management process group with all other process groups. Figure 10.5 shows the interactions between process groups within the project, including the main inputs and outputs of process groups. With the exception of the process control group, the process groups are connected sequentially. At the same time, a group of control processes can be considered independent, since its processes are used to control not only the project as a whole, but also individual groups of processes, as shown in Fig. 10.5.

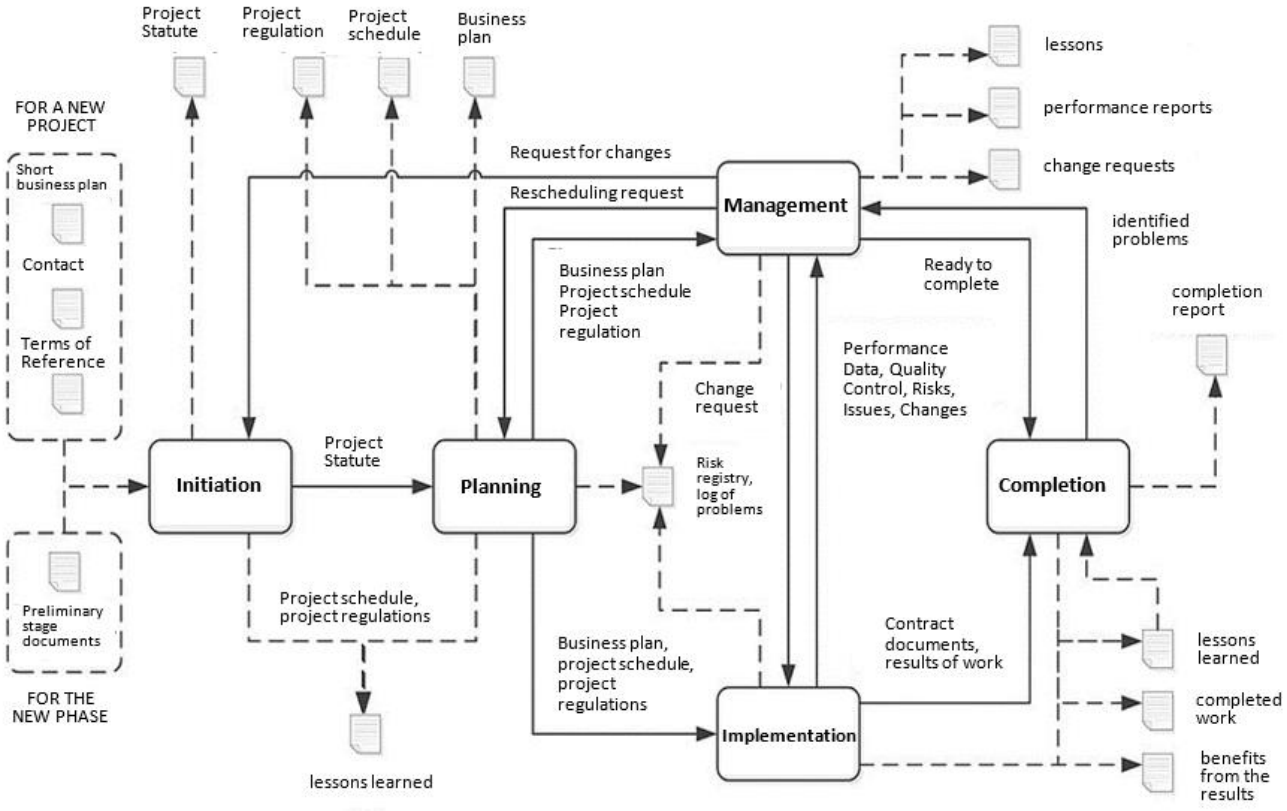

Fig. 10.5. Interaction of process groups with specified main inputs and outputs

The **Integration Subject Group** includes the processes required to identify, define, combine, unify, coordinate, control, and complete the various activities and processes associated with the project.

The **Stakeholder Group** includes the processes required to identify and manage the project sponsor, consumers, and other stakeholders.

The **Scope** includes the processes required to identify and define all tasks and results, as well as the tasks and results required.

The **Resource Group** includes the processes required to identify and acquire the necessary project resources, such as people, premises, equipment, materials, infrastructure and tools.

Time includes the processes required to plan the project and monitor the progress of the project in order to manage the schedule.

Cost The subject includes the processes required to develop a budget and monitor progress to manage costs.

Risks includes the processes required to identify and manage threats and opportunities.

Quality Group includes the processes required for quality planning and quality assurance.

The **Supplies subject group** includes the processes required to plan and purchase products, services, or deliverables, and to manage interactions with suppliers.

The Subject **Communication Group** includes the processes required to plan, manage, and disseminate project-related information.

ISO 21500 also provides a detailed description of each process involved in the project management process (see Table 10.1) and its role in project management.

It should be noted that project management processes are not project tasks. They are a metastructure for managing any project and are not project specific.

Addition 2

Glossary

EPM (Enterprise Project Management) - a set of software that provides project management and aggregated project groups (portfolios, programs, folders) in the corporate system and is based on client-server architecture.

The **milestone of the project** is a significant event in the project. Often denotes a change in project phase. Depending on the class and type of project, different life cycles of the project can be used.

The **Project Management Group** (hereinafter referred to as the PMG) is a temporary organizational unit that is assigned to perform the functions of managing one specific project.

Stakeholders - Individuals or organizations involved in the project or those whose interests may have a positive or negative impact on the results of the project.

Project Life Cycle - A complete set of consecutive phases of a project, the name and number of which is determined based on the production technology and the needs of control by the organization or organizations involved in the project.

Project Initiation is the project management process resulting in the decision to start a project or the next phase of its life cycle.

Project Management Group (PMG) Head - The responsible person who is appointed by the order to set up the project management team is responsible for the project implementation and acts as the project manager.

Project Manager - The person responsible for the implementation of the project. When a PMTL is created, these functions are performed by the PMTL leader.

Project Management Team - Project team members directly involved in project decision making and project management processes.

Project Coordinator - The person responsible for the day-to-day management of the project implementation activities (part of the project) and reporting directly to the project manager. The project coordinator can play the role of project manager.

Project Success Criteria - A set of indicators that allow you to judge the success of a project.

Critical Path - In the network model (diagram), the sequence of tasks and dependencies that determines the earliest completion of the project. The critical path will change from time to time, depending on whether work is completed ahead of schedule or later. Although the critical path is usually calculated for the whole project, it can also be defined for control events or for sub-projects. The critical path is usually the series of tasks whose time reserve is minimal or zero.

Local project - A project that is carried out within one subdivision and is not required to comply with all the requirements of the CPMS, but may use, where appropriate, certain CPMS tools.

Master Schedule - A comprehensive schedule, a general-level schedule that includes aggregated tasks (stages) and key events.

Responsibility Assignment Matrix - A structure that complies with the organizational structure of the project (OBS) Work Breakdown Structure (WBS) to assign persons responsible for the task (results) and/or project phase.

Matrix Organization - an organizational structure in which contractors can be simultaneously involved in work on multiple projects and report to multiple executives. The project manager shares responsibility with the functional managers in prioritizing and managing the work of the contractors involved in the project. There are different types of matrices, with different distribution of authority and responsibilities between functional managers and project managers.

Project Manager - The person responsible for project management.

The project manager is the person to whom the client or investor delegates the authority to manage the work within the project: planning, control and coordination of the works of all project participants

Project Network Diagram - Any schematic representation of the logical relationships between project tasks. Always shown from left to right to display the project chronology.

Network Planning. - Planning methods using network modeling and analysis techniques for a set of interrelated works.

Project Monitoring - Collecting, analyzing data, reporting on project implementation, usually compared to plan, and, if necessary, developing corrective actions.

Project Organization is a temporary organizational structure that includes all its participants and is created to successfully achieve the project goals (project team).

Project passport (Charter). (Project Charter) - A document that describes and approves the major parts of the project content, timeline and resources.

Project folders - Aggregated on a project group basis for group analysis. All projects in the project folder are required to be maintained in the CPMS.

Project Plan - A formal, approved document used to organize and coordinate the implementation and control of a project. The main point of using the project plan is to document the planned assumptions and decisions to ensure communication between project participants and to document the goals, visual area, work schedule and project cost. The project plan can be both enlarged and detailed.

Quality Planning - Defining quality standards that relate to the project and how it will be met.

Communication Planning - Identifying the information and communication needs of project participants and how they can be met.

Procurement Planning - Determine the composition of the required procurement (contracts) and their main parameters (terms, volume, etc.).

Scope Planning - Develop a documentary presentation and reconciliation of the content and boundaries of the project, which includes: project justification, main results, goals and objectives of the project.

Resource Planning - Determines what resources (people, equipment, materials, etc.), when, and in what quantities, are needed to complete the project.

Project Portfolio - a set of projects and programs connected for easy management. Note 1. Projects and programs in a project portfolio may or may not have common goals, but will generally have general resource constraints.

Project Scope - A set of products and services whose production is to be provided within the project.

Project Office - A separate unit that performs organizational and methodological support for project management in the Corporate Project Management System (CPMS)

Program - A group of interrelated projects and various activities, combined by the common purpose and conditions of their implementation.

Note 1. Program-level goals are usually related to the strategic goal of the organization. Usually the refinement of goals and requirements for results take place during the program progress.

Note 2. Running a single project being the part of a program may not produce tangible results (revenue), while implementing the entire program provides maximum efficiency (profit).

In most cases, the program can be considered as a complex, large-scale and resource-intensive megaproject.

Project management software - A class of computer programs designed specifically to plan and control the costs, timing, and other components of a project.

The project product is the main end result of a project delivered to the customer, usually defined in the product specification.

Project - A purposeful, temporary activity designed to create a unique product or service. Project implementation is characterized by specific ways of work organizing and management.

Note 1. Projects are aimed at achieving specific goals. However, in some projects the goals and requirements for results may clarify the extent of the project implementation.

Note 2. The degree of uniqueness can vary greatly from one project to another. Uniqueness can be related both to the ultimate goal of the project and to the ways of their achievement.

Note 3. As a rule, projects involve the coordinated implementation of interconnected activities by several contractors.

Note 4. The project involves the establishment of a temporary organizational structure to achieve its goal.

Note 5. A large project may consist of several lesser projects (sub-projects).

Subprojects. Projects are often subdivided into components for which dedicated management is organized (sub-projects). Sub-projects can be allocated according to the project progress (such as individual project phases) or according to the structure and specifics of the project outputs (products). Usually sub-projects are considered and managed as projects.

A **project-oriented organization** - Any organizational structure in which the project manager has full authority to determine priorities and to guide the work of those involved in the project.

Project-oriented management - Management approach, in which many orders and tasks in production activity of the organization are considered as separate projects, to which the principles and methods of project management are applied.

Project Office (hereinafter referred to as PO) is a division of the enterprise that is responsible for the project management organization.

Project Risks - unspecified events or potential situations that adversely affect the success of the whole project or individual project results, or events, which may cause unanticipated losses. Project risks are determined by the probability of occurrence of risk events and potential losses.

Regulation - A normative document describing the sequence of operations, responsibilities, procedures for interaction between contractors (participants), as well as the procedure for using resources and the procedure for managing and making decisions to improve the efficiency of the business process of project management.

Project Registry - An ordered collection of projects, portfolios and project folders that are published on the Project Server of the IMSC. Special software tools are used to analyze and manage the project registry.

Activity (task) - An element of a project executed in the process of its implementation. The task usually has an expected (planned) duration (duration), an estimated (expected) cost and the required resources. Work is often divided into tasks. A responsible person or executor is assigned to perform the task.

Project schedule - planned dates for the work and planned dates for the occurrence of project milestones ("milestones").

Milestone Schedule - a top level schedule that displays the timing of control events and milestones.

The result of the project - any measurable, tangible, determined "output" or result that must be obtained to consider a project or part of it to be completed. Usually used in a narrower sense with respect to external results, to be approved by the sponsor or client.

Project Sponsor - The head of a directorate or other unit of the company responsible for a particular project who has sufficient authority and resources to ensure the implementation of the project. Sponsor approves project budget, content and project timeline. The sponsor has the possibility to stop the project, change the terms and specific tasks of the project, and provide additional resources, if necessary, for the implementation of the project, both material and human.

The **Project Strategy** defines the directions and basic principles of project implementation; describes what intermediate results and in what sequence must be performed to achieve the whole project facing the ultimate goal.

Work Breakdown Structure - A hierarchical structuring of project work, focused on the main results of the project, defining its visual area. Each lower level of the structure is a detail of the top level element of the project. An element of the project can be both a product, a service and a package of tasks or work efforts.

Project structure - hierarchical decompositions of a project into components (elements, modules) necessary and sufficient for the effective implementation of the project management process to the benefit of different project participants.

Project Integration Management - a project management part that includes the processes required to properly coordinate the various elements of a project. This includes developing a project plan, executing a project plan, and changes management.

Project Quality Management - A project management section that includes the processes necessary to ensure that the project meets the needs for which it was designed. Includes quality planning, quality assurance and quality control.

Project Communications Management - a project management section that includes the processes required to organize the collection and distribution of reliable project information. It consists of communication planning, information sharing, project implementation reporting and administrative completion.

Project Procurement Management - A project management section that includes the processes required to ensure the delivery of products and services from the outside. It includes supply planning, proposal planning, request for proposals, sourcing, contract administration, contract closure.

Project Conflict Management - a process in which, through the use of management technology, various disagreements and conflicts, both technical and personal, that arise in the course of work on the project are resolved.

Project Scope Management - A project management section that includes the processes required to ensure that all necessary tasks and only the tasks required to successfully complete a project are included in the

project. It includes work initiation, visual area planning, visual area definition, visual area confirmation, and control of visual area changes.

Project Time Management - a project management section that includes project time management processes that are required to ensure timely completion of a project, including: task definition, task sequence determination, task duration estimation, schedule development and calendar control plan.

Project Management (PM) - perform actions that utilize knowledge, skills, methods, tools, and technologies to execute a project to achieve or exceed project expectations. It consists of planning, organization, monitoring and control of all components of the project, as well as the motivation of the project participants to achieve its goals in due time with the agreed cost and quality of the work.

Project Risk Management - a project management section that includes processes that relate to the identification, analysis and appropriate risk response of a project. Includes risk prediction and determination, quantification of risks, development of risk response methods and risk response control.

Project Cost Management - a project management section that includes the processes required to comply with an approved project budget. It consists of resource planning, costing, budgeting and budgeting, and cost control.

Project Human Resource Management - a project management section that includes the processes required to make the most effective use of project personnel. It consists of organizational planning, staffing, team building and development.

Stakeholders - Individuals and organizations directly involved in the project or whose interests may be involved in the project.

Project Phase - a set of logically interconnected project tasks that, achieves one of the major or significant intermediate project results. Sometimes a partial combination or simultaneous execution of individual phases of the project is possible.

Project Objectives - the desired result of the activity that is achieved as a result of successful implementation of the project under the given conditions of its implementation.

Project team members - People who are directly or indirectly accountable to the project manager.

Addition 3

Table 11.1. Project management software

№	Name	Opportunities	Specifics
1	5pm	Another easy-to-use web project and task management system. Consists of a calendar, a file repository, a network schedule, reports, and an access system.	Integrated with email.
2	AB-TASKS	Project management system suitable for small teams. With it, managers, developers, and clients can collaborate in projects.	
3	ActiveCollab	A system, designed to run one or more projects. Includes internal forum, tasks, file repository, scheduler and calendar.	Designed for installation on a server in a LAN.
4	Acunote	A project management system designed for small teams of developers using flexible project management methods, (Scrum, etc.)	It has a simple and intuitive interface.
5	Asana	Convenient and quite simple service that allows you to manage projects and project tasks.	Allows integration with email. There is a possibility of mobile access. For teams of up to 30 people are free of charge.
6	Assembla	Project management system suitable for developers within the social network. Allows you to quickly find contractors for your own projects and participate in ongoing projects.	The system workspace includes support section, file repository, internal chat.
7	Basecamp	Effective and fairly simple project management system. Includes files, project log, tasks, wikis, profiles, discussions, calendar.	With this system, productive collaboration with partners and clients can be organized. There is a possibility of mobile access.
8	BiPulse	Online project management system. Project management is based on Agile principles.	The system includes a great deal of information regarding project management.

Continuation of Table 11.1

9	Clarizen	An online project management system for small businesses. The system consists of a personalized dashboard, tasks, reports, Gantt chart.	Integrated with MS Project, MS Outlook and AutoCAD. There is an API for developers.
10	Comindware Project	Professional "cloud" system for automation of project planning and execution.	Adapted for Android and iOS and integrated with MS Outlook.
11	Comindwork	The system is designed to manage projects and tasks online. It involves collaboration and teamwork. There are options for categorization, setting tasks, time tracking.	Corporate Wiki, RSS and E-Mail alerts, repository files, and other attributes are provided.
12	Desk-Away	A project management system that includes a messaging and report system, text editor, file repository, a project planner, a summary bar and customer support system.	
13	Deskun	Project management and customer support system.	Allows you to do E-Mail support for corporate clients and perform project management from the GMail interface.
14	Devprom	Deployed on local server and used as a SaaS solution. Includes Multifunctional Storage Files, Communication Blocks.	A free system that allows you to manage projects aimed at developing and implementing innovative products
15	Flowlu	Online project management system. Used for collaboration as well as financial management and CRM.	Extensive opportunities to adapt to the business processes of different companies. There is mobile access. There is a free version.
16	Gantter	It can be a great alternative to MS Project. Suitable for resource planning and project control, time planning. There is a network schedule and the ability to update the percentage of work completion.	You can import projects from MS Project. Part of the free online project management system.
17	GroupCamp Project	Online project management service. Thanks to functional and simple applications, productive work in the cloud is available. The service includes task management and checkpoints, online discussion.	The system is confidential and secure. Integrated with Google Apps. Can be integrated with email, contextual gadgets, Google Docs.

Continuation of Table 11.1

18	HiTask	Simple and convenient system that allows you to work together on projects and tasks.	The system includes chat for project participants, a reminder service, a calendar, group task pooling and task sorting.
19	Intrawork	Contains many features that allow you to manage the execution of projects of varying complexity.	Corporate task management service.
20	IPI.MANAGER	Project management system, suitable for installation on your own site and allows you to process client Internet requests.	Features simple interface, advanced notification tools, tree-based task system, reports available for executives
21	iQ300	Convenient project management system for small organizations with a clear and accessible interface.	Provides the ability to create projects, tasks and checklists, comment, attach documents and custom actions.
22	Kanbanchi	Project management system for G Suite - a set of corporate "cloud" services for the Internet.	It is possible to create kanban boards. Free basic functionality.
23	Lement Pro	System of task and project management, control of achievement of goals includes its own GPU and workflow.	Supports MS Excel and integrates with MS Project. Suitable for construction companies. There is a mobile application.
24	Microsoft Planner	A system that allows you to organize collaboration and plan projects within Office 365	Easily integrates with other Microsoft services.
25	Microsoft Project	Corporate system that allows you to manage projects, allocate tasks and resources to employees, engage in budgeting and performance monitoring.	The system is integrated with MS Outlook and MS Sharepoint.
26	Neaktor	Task management and communication system with many settings.	It includes a calendar, a mail client, a chat, a news feed, and employee records.
27	PM Arena	Web-based system for managing individual projects and project portfolios.	Focuses mainly on the use of public authorities.
28	Producteev	An online task management system supporting collaboration. Includes a plugin for MS Outlook and a widget for GMail.	Tasks can be created remotely from mobile devices, social networks, messengers and e-mail. There is a free version for two people.
29	Project Kaiser	Russified project management system of hierarchy type with a simple interface. It includes a task management and support of executors.	The system is stable, fast and can be installed on any platform. A free download version is available for five users.

Continuation of Table 11.1

30	ProjectOffice	Web-based project management system for the same type of projects.	Provides a modern and convenient toolkit for controlling and accounting project resources.
31	PTYSH	System of project management and task management.	It has special features for freelancers, SEO companies and web studios. There is a free version.
32	Pyrus	GMail-like collaborative tasking system. Perfectly integrated with email, Google Apps and Active Directory.	It includes business processes, contacts list, file repository, APIs. Available for Android, iPhone, iPad and WinPhone.
33	Rovertask	Intuitive task manager for teamwork and project management.	For small projects.
34	Smartsheet	A very simple and understandable system for managing projects and tasks with an interface such as MS Excel.	There is a free version.
35	Staply	The system is a symbiosis of notepad and messenger.	Easy to apply and suitable for collaboration. There is a free version.
36	TeamBridge	An online project and company management system, great for collaboration.	Employees of the organization working in the same environment can exchange information. Executives can watch the big picture in real time.
37	Teamer	Web project management service. Suited to create projects and monitor the status of their implementation.	There is a file attachment and comment feature, ICQ and Jabber reminders. There is a portable version.
38	Time Master	Personal system with the ability to work on projects and tasks.	It includes email and SMS reminders, tasks log, contacts, projects, tasks and calendar.
39	WebAsyst	Set of services with centralized entry point. Includes online store, project management tools, tools for E-Mail marketing.	There is a Russian version. It is possible to install on your own server.
40	Workdoer	Free system for managing tasks and projects online with scheduling tasks.	A simple, easy-to-understand, task-friendly interface contributes to effective teamwork.
41	WorkFlowSoft	A system for managing projects, work packages and tasks.	Used in collaboration with companies that use MS Office 365.
42	Worksection	Online project management system in Russian.	Contains time accounting, repository files, calendar, task manager with comments.

Continuation of Table 11.1

43	Wrike	A system that allows you to create and group tasks in projects, and control the progress of their execution.	Its main advantage is advanced functionality for collaborative activities. The system has network schedules and reports on the work.
44	Zoho Projects	It includes a repository and document editors, organizer, calendar, forum, reports, meeting planner, wiki documents, time tracker.	The system is very convenient for real-time operation. Ability to import from MS Projects. Russified. There is a free version for one project.
45	Адванта	Cloud project and business management system. It is considered an analogue of Primavera, Clarizen and MS Project.	The advantage is that it is designed specifically for government organizations and is focused on executives.
46	Кларіс	An online project and task management system.	The system includes instant messages, e-mail alerts, convenient workflow.
47	ЛідерТаск	Cross-platform task manager that synchronizes tasks between PCs, laptops and mobile devices.	Integrated with email, includes a built-in calendar, task files, and task comments
48	Мегаплан	Project management system for small and medium-sized companies of any profile.	The system includes transaction control, module for work with employees, task manager, forum, internal mail, file server, billing, CRM interaction model.
49	Планіро	Includes task templates, several types of reports, Kanban boards, Gantt charts, discussion and task timing.	There is a time tracker for Mac. There are mobile versions for Android and iOS.
50	ПланФікс	A teamwork management system that facilitates the organization and management of collaborative employee activity.	Suitable for business, NGOs, non-profit organizations, and any team working on a common mission.